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THE NATURE OF COSMIC RAYS AND THE CONSTITUTION OF MATTER

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RECENT studies of cosmic rays have revealed the existence of a new elementary particle, the "meson" or "mesotron," of a mass intermediate between the electron and the 2,000 times heavier proton. This discovery has reanimated the old discussion about the constitution of matter.

Up to ten years ago all matter was considered to be composed of negative electrons and positive protons, carrying equal but opposite charges.[1] Most of the more conspicuous properties of matter, like color, shape or chemical reactivity, could and can still be understood to be due to the electrons that form the outer parts of all atoms and molecules. Only the weight and the radioactive properties of an atom are due to the positively charged nucleus that forms the center of the atom, holds the electrons together and compensates their negative charge. All nuclei have masses that are nearly exact integral multiples of the proton mass; and for keeping these protons together negative electrons were imagined to be distributed among them. Such composition, incidentally, would make it understandable that radioactive substances may emit electrons, as many do.

Then the neutron was discovered, a particle of about the same mass as the proton but, as the name suggests, electrically neutral. This particle is certainly a part of the nucleus, and the assumption that protons and neutrons are the only constituents of the nuclei removes many theoretical difficulties connected with the formerly assumed presence of electrons in the nucleus. The electrons have, so to say, not enough space in the nucleus; their "size" and their magnetic moment is much too large. So the positive charge number Z of a nucleus is now supposed to be equal to the number of protons in it, and the difference of mass A and charge Z determines its number of neutrons. To understand from where the electrons of radioactive atoms come, it has been assumed that the neutron is able to emit an electron and change itself into a proton —although no one has succeeded so far to prove directly the instability of the neutron. Many artificially produced radioactive atoms emit—instead of a negative electron—a positively charged electron, called positron, so that the reverse transformation of a proton into a neutron with simultaneous emission of a

[1] Compare the article by the present author in Volume 40 of this journal (pages 307–312, 1935) and the article by K. K. Darrow, "Forces and Atoms," in the recent March issue of this journal.

positron had to be assumed also. For explaining the observed phenomena of the radioactive processes the existence of one more "elementary" particle is necessary, namely, that of the neutrino, a neutral particle of even smaller mass than the electron—although it has not been possible so far to observe it directly. It has to carry away a part of the energy set free in the radioactive process and a part of the angular momentum of the nucleus, so that the laws of conservation of energy and momentum are fulfilled. Thus we have already four or even five "elementary" particles, two heavy ones, the proton and the neutron, and two or three light particles, the negative and the positive electron and the hypothetical neutrino.

The main difficulty in the whole picture is to understand the forces that bind the protons to the neutrons in the nuclei. These forces are apparently very strong when the particles are near one another, and diminish rapidly with increasing distance between them. Hence these forces are not of electrical nature, because electrical forces are known to change less rapidly with the distance, and neutrons carry no electrical charge anyhow. A theory was developed where the above-mentioned transformation of a neutron into a proton, together with the opposite process, was supposed to be responsible for the nuclear binding and for the radioactive emission of electrons. But the forces due to an exchange of electrons between protons and neutrons are not

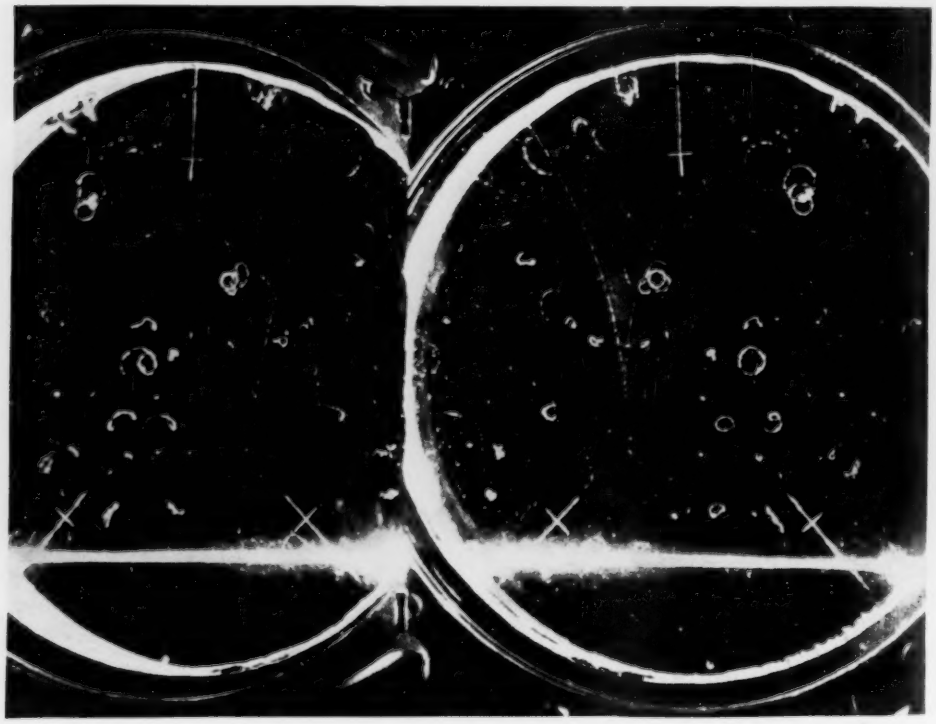

FIG. 1. CLOUD CHAMBER TRACKS

OF A PAIR OF A POSITIVE AND A NEGATIVE ELECTRON BENT IN A MAGNETIC FIELD. THE PAIR ORIGINATES IN THE GAS OF THE CHAMBER PRODUCED BY A NON-IONIZING GAMMA RAY. THE SMALL CIRCLES ARE THE TRACKS OF SLOW ELECTRONS. (FOWLER, GAERTTNER AND LAURITSEN)

strong enough, the mass of the electrons is too small. That is why, in the year 1935, Yukawa introduced into the theory of nuclear forces a new particle, supposed to be about 160 times heavier than the electron, and showed that such particle could give rise to the short-range force between neutrons and protons. Two years later, such particle of about the right mass, the meson, was actually found in the cosmic rays.

These rays, discovered by Victor Hess

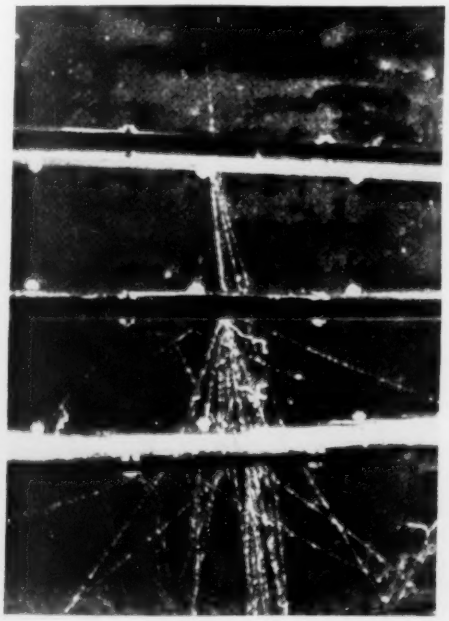

FIG. 2. A MULTIPLICATION SHOWER OF ELECTRONS DEVELOPING IN A CLOUD CHAMBER CONTAINING THREE HORIZONTAL METAL PLATES BUT NO MAGNETIC FIELD. (FUSSELL)

nearly thirty years ago, gave and give still much to think about. They come undoubtedly from outside the atmosphere as their number increases with increasing height above sea level, but they show no close relation to the position of the sun or any part of our galaxy; hence they must be of cosmic origin. They are partly uncharged photons, an electromagnetic radiation like x-rays or gamma rays of very high energy; partly

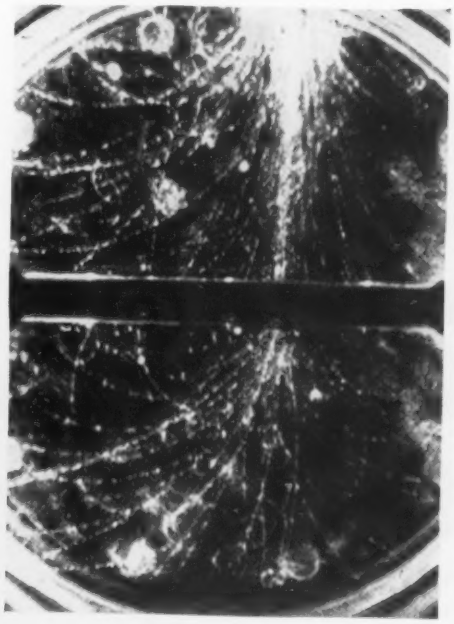

FIG. 3. A COSMIC RAY SHOWER OF MANY HIGH-ENERGY ELECTRONS INCIDENT NEARLY NORMALLY ON A 1-CM PLATE OF PLATINUM. THE CLOUD CHAMBER IS IN A STRONG MAGNETIC FIELD. (NEDDERMEYER AND ANDERSON)

FIG. 4. CLOUD CHAMBER TRACKS OF ELECTRONS AND OF ONE FAST PROTON FROM THE DISINTEGRATION OF BORON BY ENERGETIC DEUTERONS (NUCLEI OF HEAVY HYDROGEN). THE PROTON IS NOT APPRECIABLY DEFLECTED IN THE MAGNETIC FIELD. (BAYLEY AND CRANE)

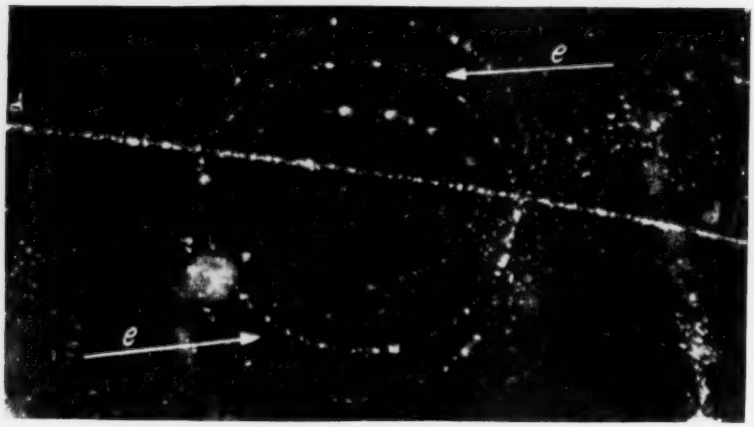

FIG. 5. A MESON TRACK (d–d)
SHOWING SOMEWHAT STRONGER IONIZATION AND LESS CURVATURE THAN THE ELECTRONS (MARKED BY ARROWS e) DESCRIBING CIRCLES IN THE MAGNETIC FIELD. (WILLIAMS AND PICKUP)

they are electrically charged particles, as they are deflected by magnetic fields and behave like extremely energetic electrons and protons. But many behave differently, they penetrate, besides the whole atmosphere, hundreds of feet of water or rock. These can not be electrons or protons. Electrons even of very high energy are stopped by a few feet of water; they produce gamma rays, which in their turn produce pairs of positive and negative electrons. Such alternating "annihilation" of electrons and "materialization" of gamma rays give rise to the "multiplication showers," frequently observed in the higher atmosphere and quite often also at sea level. The instrument usually employed for studying the properties of cosmic ray, and especially of the showers, is the Wilson Cloud Chamber filled with suitable gas mixtures; charged particles produce ions in such a chamber, and small droplets condense on the ions, making it possible to see and to photograph the tracks of the particles. Fig. 1 is such a photograph. It shows the stereoscopic picture of a cloud chamber with the tracks of a pair of electrons produced by a gamma ray, which does not ionize the gas directly and is therefore not visible. The cloud chamber itself is exposed to a strong magnetic field deflecting the electrons from their straight path in one or in the other direction, depending on the sign of their charge. The amount of curvature of the tracks in the magnetic field allows the determination of their energy.[2] Fig. 2 shows how the fast electrons multiply and Fig. 3 shows a shower of a great many electrons.

Protons on the other hand, because of their high mass, are not able to produce such showers; but they ionize much stronger than electrons of the same energy, since they move more slowly. Their dense tracks in a cloud chamber can easily be recognized and distinguished from those of electrons (see Fig. 4).

However, the penetrating particles of the cosmic rays give rise neither to multiplication showers nor to as dense tracks as protons, and they penetrate easily many inches of lead: these are the mesons of intermediate mass (compare Figs. 5–7).

The determination of their mass is

[2] Directly determined by the product of field strength and radius of curvature is the *momentum* of the particles, and if their velocity is near that of light one obtains also their energy, otherwise one has to know the mass of the particles for the calculation of their energy.

rather difficult. One has to measure the curvature of their tracks in a strong magnetic field and the ion density they produce—or better their curvature before and after penetration of a lead plate. The intermediate mass of the meson was established in this way; but the results, obtained so far, still scatter too much and are not accurate enough for determining a definite value of the mass of the meson. They do not allow to decide whether their mass is 100 or 300 times as big as that of the electron, or whether there are different mesons having different masses. It would be rather odd if there were no unique mass, and one hesitates to believe it until more exact experiments give definite proof.

Another important question is whether the meson of the cosmic rays is actually the particle responsible for the nuclear forces. If it is, it has to be unstable according to the theory and has to change somehow into an electron, as only electrons are emitted in radioactive processes. As a matter of fact, such instability of the cosmic ray mesons and their transformation into electrons has been observed and their lifetime has been determined to be of the order of one or two millionths of a second. Consequently, the mesons can not be the primaries of the cosmic rays as they come from far outside of our earth, they would have disappeared, respectively, they would have been transformed into electrons before reaching our atmosphere. We know that the primaries of the cosmic rays are charged particles, deflected by the far-reaching magnetic field of the earth; for the cosmic ray intensity changes appreciably with the magnetic latitude; and their East-West asymmetry proves that they are mostly, if not all, charged positively.

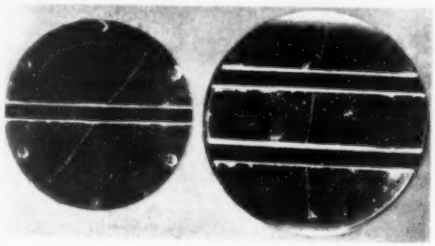

FIG. 6. TWO PICTURES OF MESONS
PENETRATING METAL PLATES WITHOUT PRODUCING SHOWERS. MESONS EASILY PIERCE LEAD MANY INCHES THICK. (ANDERSON)

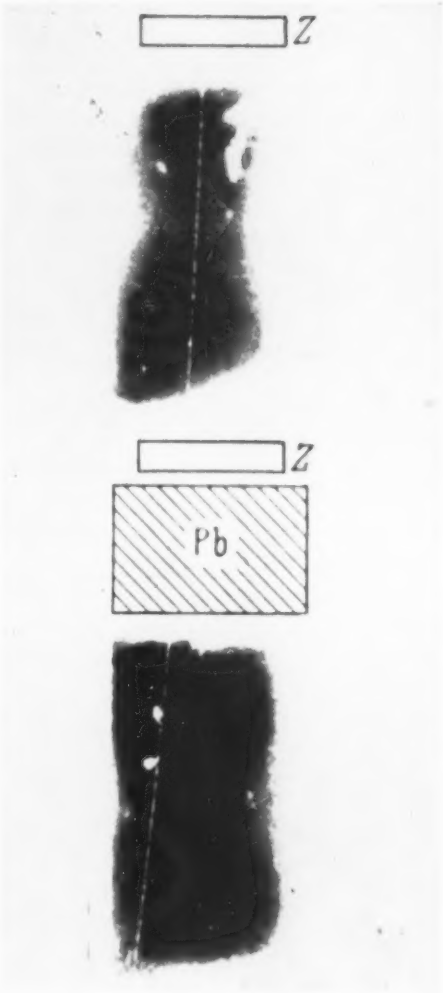

FIG. 7. TRACK OF A MESON
IN TWO CLOUD CHAMBERS MOUNTED ABOVE EACH OTHER. THE PARTICLE PENETRATES A LEAD PLATE OF SIX-INCH THICKNESS BEFORE ENTERING THE SECOND CHAMBER. (EHRENFEST, JR.)

Recent studies with counters and other instruments carried up to the highest mountains and in balloons to heights of a hundred thousand feet have shown that mesons are generated in the atmosphere, and that probably heavy particles, protons or even heavier ones, are the primaries. These produce by their collision respectively by their electromagnetic interaction with the molecules of the atmosphere, directly or indirectly, the mesons, the electrons, the gamma rays and the showers that we observe as cosmic rays.

But the origin of the primaries of the cosmic rays is still a great puzzle. We do not know the processes responsible for the production of such immensely energetic particles. Some of them carry a million times more energy than the most energetic particles we can produce artificially. And as to the question of the constitution of matter our answer is still rather incomplete. We know that all matter consists of atoms, that the atoms consist of tiny nuclei surrounded by electrons and that the nuclei consist of protons and neutrons. There must be strong forces acting between the protons and neutrons holding the nuclei together. But we do not know what they are. They are not of electrical nature as we have seen, and many theories have been tried for understanding these forces. The discovery of the meson in the cosmic rays has raised some hope for reaching the goal, but this fundamental problem is still far from being solved.

The more science progresses the more new problems arise.

THE DEATH OF THE GAMBIAE

In the last number of this *Review* it was reported that no evidence of the presence of the *Anopheles gambiae* mosquito had been discovered in Brazil during the final forty-seven days of 1940. It will be remembered that this was the mosquito which, imported from Africa by airplanes or fast navy destroyers, had been responsible for a widespread and devastating malaria epidemic. As a malaria vector this mosquito was more efficient than any anopheline indigenous to America, and its further spread was greatly feared. Over 12,000 square miles of northeastern Brazil became involved; more than $2,000,000 was spent and an army of over 2,000 trained workers was mobilized, under the leadership of Dr. Fred L. Soper, of The Rockefeller Foundation, to attack the invaders.

A year ago we reported that it no longer seemed rash to speak of the eradication of gambiae from Brazil, although some mopping-up operations might be necessary if any areas became infested at the onset of the rainy season in 1941. It is a satisfaction to report that no such infested areas were discovered during the entire year. Except for a short period of two months in a small area in which infestation was first found in October, 1940, no control measures were carried out during the year in the gambiae region, and a free opportunity was thus afforded for any remaining members of the species to increase their numbers at will. Thorough search by well-trained and selected personnel throughout the entire area of previous infestation, and even far beyond the old limits, failed to reveal the presence of a single gambiae.

This particular battle would seem to have been won—at great labor and cost, and after enormous suffering. But the gambiae mosquitoes have apparently not given up their intention of establishing themselves in the Western Hemisphere. Airplanes are crossing the Southern Atlantic with increasing frequency, and commercial planes, of course, are now carefully fumigated, both after they leave Africa and again before their passengers are discharged in Brazil. A dead female gambiae was discovered after fumigation in a plane arriving in Brazil in October, 1941, and two more in January, 1942. The original infestation, with all its subsequent miseries, could readily have been started by a single fertilized female. Truly the price of liberty, as far as this malaria-carrying mosquito is concerned, is eternal vigilance.—*Raymond B. Fosdick in "The Rockefeller Foundation Review for 1941."*

AN ANTHROPOLOGIST IN RUSSIA

III. IN MONGOLIA

By Dr. A. HRDLIČKA

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FIELSTRUP, the young student I engaged at Petrograd, has joined me at Irkutsk, brought all the baggage, and will now be my companion.

At Khiakhta, an important Russian boundary station, reached after a long but uneventful boat trip on the Selenga River, engaged a man to take us in his "troika" to Urga. Had to take what could be had, for but few knew the roads and none were inclined to risk the journey. On August 31, after all sorts of preliminaries and with the generous help of the Russian boundary "komisar," Colonel Chytrovo, who even urged on me an old army gun and a bag of ammunition against bandits, we started for Urga. Our outfit—one horned-toad (the best term that fitted his disposition) driver; one time- and road-worn "troika" (springless, hard, half-open cart, pulled by three horses); a layer of hay inside the cart instead of seats; and in the none-too-large inside also a provision box, with a ham, cheese, bread and suchary (dry biscuits), my two raincoats, my "spalny mishok" or a Russian officer's bed-roll which I got at St. Petersburg, a blanket, cushion, some clothes of my companion, a light satchel with the smaller camera, two boxes with plates and the larger camera. A bag of oats was placed crosswise in the back and another in front. The bed-roll came between the two of us, the satchel in the back, Fielstrup's blanket, etc., and my coats were spread over the bed-roll, the food box had to get out and was tied in the front next to the driver, while the two heavier boxes were fastened on the projection of the rafters in the back of the cart, the driver added an old bag filled with his own provisions and a few lengths of old rope, the gun was placed along the side of the car—and all was ready. We climbed in, stretched our legs as well as we could on things and off we went, bumping, rocking, knocking until the base of the head hurt, towards Mongolia. Soon the legs would get stiff and the head keep hitting the crude sticks in the frame of the "cover"—but that was eventually overcome in part by the forming of new habits and instincts.

Were soon over the boundary—a lone Cossack on guard at the boundary post—through the dirty but picturesque Chinese "Maimatzen" (trading town) beyond, and on the grassy boggy plain of central upper Mongolia. From here on almost constantly met Mongolians on small shaggy horses, and I soon learned, to be amply corroborated afterwards, that they were natural horsemen, horsemen by and from birth almost, men and women and the young. Also saw a group of grazing double-humped camels—from some caravan of the Gobi Desert. And all at once I saw in the grass, a bare rod from the road, a white round object—a human skull. Had my first trophy where least expected. Found soon the reason: the Mongols do not bury. They throw the bodies of the dead out on the hills or into gorges near their settlements or camps, to be devoured there by dogs, wolves, vultures and ravens, and what remains of the bones is left to whiten the soil. The bones and even parts with flesh still on are dragged about by the dogs and occasionally brought by them even into such towns as Maimatzen or Urga, without anybody interfering or paying attention. This skull must have

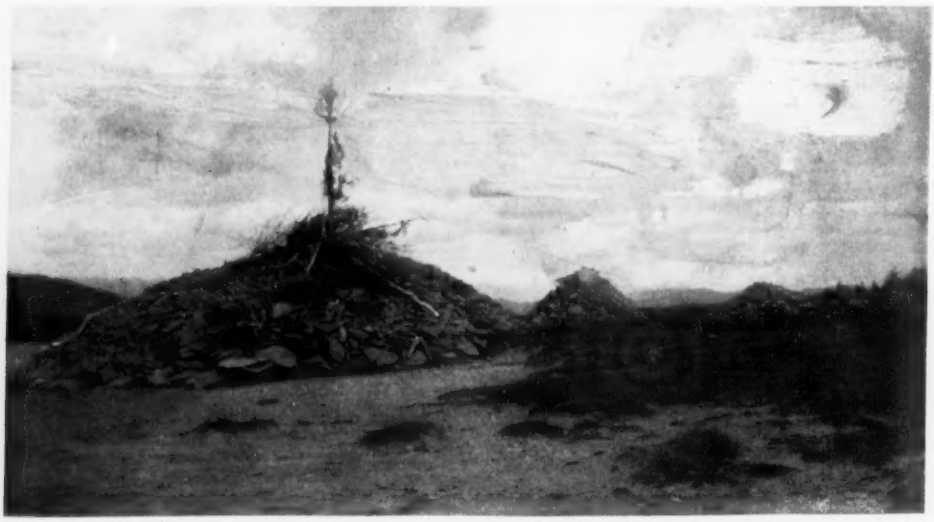
A MONGOL TRAVELING NEAR THE IRO RIVER

HE HAS THE CHARACTERISTIC HORSE, POSTURE IN SADDLE AND OLD-FASHIONED GUN WITH FORK SUPPORT. THE MAN'S PHYSIOGNOMY AND COLOR ARE MUCH LIKE THOSE OF AN AMERICAN INDIAN.

been dragged from some dead body at a distance, for it was alone and without the lower jaw; and no native would touch such a specimen.

Some white low pinnacle-like monuments are seen on a hill to the left—a sort of open-air, crude monument-altars, with which we meet in a number of instances afterwards, near lamaseries.

Near the monuments and scattered



ROCK "MOUNDS" ON TOP OF THE PASS ON THE ROAD TO URGA

TRAVELERS REACHING THIS SPOT PICK UP A PEBBLE, MOISTEN IT WITH SALIVA AND RUB IT OVER THEIR BODY MURMURING THANKS FOR HAVING SAFELY REACHED SO FAR AND PRAYING FOR STRENGTH AND SUCCESS ON THE REST OF THEIR JOURNEY.

farther on the first yurtas—the characteristic transportable dome-shaped houses or huts of the Mongols. They are round, with subconical or rounded roof, made of lattice-work, and covered with thick dark felt fastened to the frame with cords. They are about twelve feet in diameter, nine or ten feet high in the middle, with a door towards the south and a smoke opening (closed by a flap at night) in the top. They are the same, we found later, all over Mongolia, and may be bought ready to put up in the markets. They remind one very closely of the dome-shaped huts of the Apache and other of our Indians. They can readily be undone, packed on a car and moved wherever the owners are bound to. Are warm and would be excellent shelters, were they not crowded with things and humans and especially were they clean; but they are only clean when new and empty, which is once in their life. They must accommodate all the family, and its possessions, and when colder even some of the household animals. Their felt cover when new is near white but with age and smoke gets blackish-grey. Inside are a primitive iron range or firebox and a brazier in the middle, a sort of Chinese-made cabinet and upon it an altar at the wall in the north part facing the door which opens towards the south, a little stool at the foot of this cabinet, a low primitive bedstead along the wall to the right and perhaps also to the left of the altar, horse accoutrements, water pails, a crude kitchen-stand, sheep-skin rugs and other articles, taking the rest of the space along the walls, while a mat or two (occasionally) on the ground complete the equipment. In such a yurta on one occasion there were twelve of us at supper. I also slept in one, though with a smaller family. However, of those things later.

Before long after Maimatzen the road began to rise to a low wooded range, and afterwards it was just up or down moderately high chains of hills and ridges, running for the most part in an east-to-west direction.

At 2:00 stopped for lunch on a small knoll in a larger basin among the hills and here it was so warm that we had to take our tea pot under a pine, where we made a small fire. At this top I learned some of the habits of the "yamshchiks" or drivers in these parts. One of these habits, for which we had to pay dearly late that same day, was to stop three hours, "to rest the horses."

While we were waiting here there came by two Russians in an open farm wagon half filled with a variety of mushrooms. Great many of these grow in the woods here, and they are much favored by the Russians. They gather them in astonishing quantities, eat many fresh, boiled or fried or scrambled with eggs, and salt the rest of the caps in casks or barrels, in which they may now be seen for sale in all the markets. A traveling Russian here, we saw later, carried a small cask of the salted caps with him to supplement his meager other provisions. A curious thing—all the Slavs and many other Europeans like wild mushrooms—perhaps a faraway taste acquired while their ancestors were surrounded with forests. The pine woods here looked much like those about Washington—things repeat themselves amazingly in many parts of the earth. . . .

At 5:00 started again and had about twenty-five miles before us to a Russian farm on the Iro River, to the owners of which I had a letter of introduction. The road led over hills and long inclines, and we were going at quite a good gait, but the day also was going, and clouds began to appear above the range before us. Also we were beginning to be bothered much by flies and mosquitoes. Towards 8:00 it got dark, the clouds increased and there was distant lightning. We were crossing another low ridge, the clouds and lightning with deep rum-

blings were coming nearer. The sky above too now was overcast, and before long occasional lightning extended all over the sky and a slight rain was beginning. It was now pitch dark, and we were passing down along an ugly gorge to the right, disquieting glimpses of which we got now and then through the lightning. At one spot a big flash and stroke frightened the horses and they jumped wildly and started to run, but fortunately not off the road before the driver controlled them. Then came a heavy rain, sheet lightning and thunder. We descended to the grassy flats of the river, where on these flats somewhere before us was Karnakovo, our destination. And then we came to a big pool of water covering the track and vicinity. The mosquitoes soon became a pest here, except when it rained harder. There was absolutely nothing to be seen anywhere except by lightning. The driver thought Karnakovo was still distant, and was afraid to cross the deep pool before us. Another poor track was traced a little way back leading to the left but soon seemed to end among the rocks at the foot of the slope down which we came. There was no sign that the storm might soon cease, and we knew not what marshes or holes were before us. So we had to stop here over night. Fortunately I had my "mišok" and rain coats and rain trousers, and the water did not now fall in torrents. So with everything on, the rain coats over the exposed parts of the bodies and the wagon turned with back against the wind, F. and myself huddled in the wagon, so narrow as to accommodate two only when extended but so short that one could not extend fully; and with mosquito netting over our heads passed a miserable portion of the night. The driver made himself a little shelter in front of the wagon and slept on his things on the wet ground.

The rain must have stopped late after midnight; and at about half past three, with the first signs of the dawn, I was awakened by the stamping of horses near the wagon, and by a curious hum above our heads as if of bees. This soon proved to be the song of innumerable mosquitoes that were waiting for their victims. The driver was up, too. We crawled, half cramped, out of the wagon; and then, as soon as we could see clear—there, but half a mile away from us, across the marshes, was Karnakovo! Then the safety valves blew off for a minute. . . .

However, did not dare even then to go over the pool and the soggy ground beyond and so, fighting the viciously hungry mosquitoes and with two eagles screeching over us—probably had their nest somewhere in the nearby cliffs—we took the rocky road, helped the wagon with our hands and shoulders over the stones which otherwise would have wrecked it, and in a roundabout heavy way a little after 6:00 reached Karnakovo.

And here I found a Russian woman of about fifty-five, the farmer's wife, who had had advanced education, had written and published several good papers on the Mongolians, and even spoke fairly good English. We were received as warmly as friends, fed, put in warm beds to rest, dried, fed again and then taken to Mongol yurtas, and after that to a lamasery, where all were friends of Mme. Karnakova, who treated them when sick and had learned their language. We stayed over two days to recuperate, photograph, search and learn much. Here another good skull was added to my collection, and a Mongolian paid me with a "haidak," a fine light blue ceremonial silk kerchief, for having pulled (with my fingers) a bad tooth out of the jaw of his little boy. They offer these haidaks to the gods, they give them to friends, and they show with them their gratitude and friendship to others.

Then we went on again, fighting the

MONGOLS OF THE HIGHER CLASSES

Top: MONGOLS OF THE WEALTHIER CLASS IN GALA DRESS. *Bottom:* "CITY" MONGOL OF URGA.

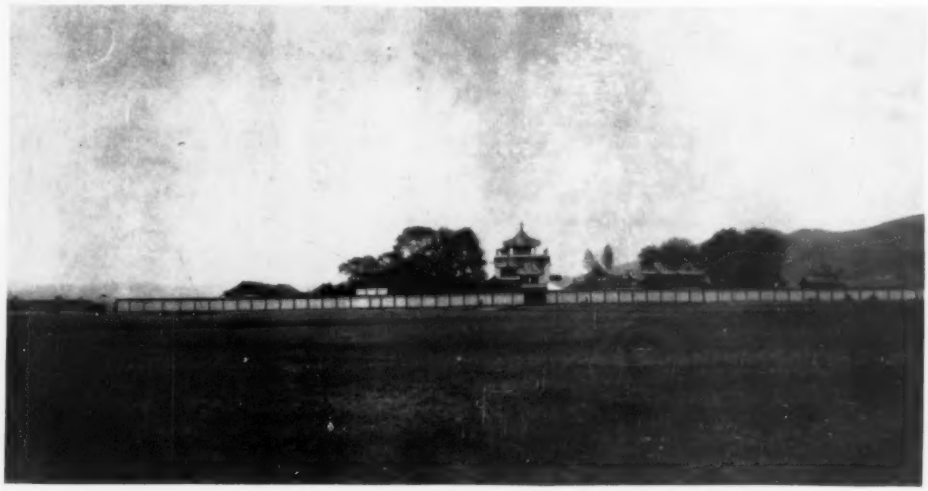
mosquito pest all the way; sleeping (if sleep it could be called!) one night in a flea-infested yurta—the next morning had twenty-eight bites on the back of one hand only; another night on the wet ground under the wagon with drizzle part of the night; and third in still another yurta, it being too cold to stay outside. Crossing some outrageous mountain roads, walking up hills to ease the

TWO TYPICAL MONGOL SISTERS

THE ONE ON THE LEFT IS SLIGHTLY OLDER AND MARRIED; THE ONE ON THE RIGHT IS UNMARRIED. THEIR EYES HAVE ALREADY LOST THE EPICANTHUS AND ARE QUITE HORIZONTAL.

YOUNG MONGOLIAN WOMAN, RECENTLY MARRIED

horses; and on better stretches of ground dozing in the wagon to make up a little for the nights. As to meals, might breakfast at 4 A.M., lunch 9:30 and dine when stopped for the day; or breakfast at 6 and lunch at 2 or 3—as the horses, not we, required, or as could be managed. And meals all the same—ham, cheese, bread, tea—but we varied the order; only the last day when cheese was out succeeded to get at a Chinese farm a supply of eggs. Of tea from four to five cups at a sitting, but not strong—a teaspoonful and a half for everything for the three of us. And thus on the seventh day we reached Urga. . . .



ONE OF THE PALACES OF THE CHIEF LAMAS IN URGA, MONGOLIA

The night in the flea-hut was almost the limit. It drizzled now and then that day and was cool. Towards evening among low hills found an old woman's skull—learned later she had been killed and eaten by savage starving dogs. Shortly after came to a hut belonging to and sometimes used by a Russian trapper. Just a little shanty, but had a loose plank floor and a damaged stove.

Managed to make tea, and after a humble supper, the driver went to sleep in the wagon so as to be near his horses that were tied to it, for we were approaching the region of the "Hunhuzes" or bandits; F. and myself stayed in the hut making our bedding on the dingy floor. Both soon asleep, regardless. But almost in no time, it seemed, I felt as if hundreds of ants were running over body, and every now and then some spot began to burn. As soon as awake enough it dawned on me they must be fleas. Nor was there any illusion about this. They were there in undreamt-of numbers. And F. was in a similar condition. So both jumped up, lit candle and endeavored briskly at least to clean bodies, then dressed and talked things over. Nothing to be done, for they were now in the bedding and no telling with what reserves under the floor. And it drizzled outside, also was cold. So to warm up a little made fire in the derelict stove, and fed it perhaps a bit too much. At all events the pipe was half rotten and before we knew the roof of the hut about the pipe caught fire. And then we hustled, poured on burning part what water there was and beat out the rest with hands, which got blistered; but saved the hut. And then just crouched meanly on

OLD LAMA, CENTRAL OUTER MONGOLIA

YOUNG DISCIPLE
FROM ONE OF THE MONGOLIAN LAMASERIES.

things until it began to dawn. How powerful it felt that morning that man was made for the day and the sun!

At the Iro, a good-sized and deep river, we had to be taken over on a primitive Mongol ferry. Beyond met a solitary Mongol horseman with his quaint long gun, with which goes here invariably a bamboo or wooden forked pedestal on which the piece is laid for aiming. Except for the gun the fellow looked exactly like an American Indian—and again and again one sees here features that are just Indian.

A Mongol caravan is a sight worth seeing, though not hearing. It consists of anywhere to forty or fifty two-wheeled carts of a type that must have been common three thousand years ago. The body of the cart is of the simplest—just a crude flat platform with a simple rough railing on each side, and a cross piece in front on which sits the Mongol—if he is riding on the cart—which however is seldom the case—for due to self-evident reasons he prefers walking or riding his horse. But the "joy forever" are the big wheels. They are made of single cross-sections of a tree, revolve on a stout home-made wooden axle on which rests the car, and are worn off each in a different way and to a different degree, with the result that as the car goes it wobbles irregularly and makes all sorts of outlandish noises. A string of such cars, with the dust they raise and with their combined grating, squeaking and other discordant sounds, is quite a thing to pass on the road. Have however seen and heard identical sight and sounds in parts of Mexico. . . .

As to the Mongol himself—the fierce ruthless warriors of Genghis Khan or Tamerlane are to-day the meekest and friendliest of people. If you see a Mongol on the road he begins to broadly smile at you from as far as you can well discern him, and he keeps on smiling, if you look at him, until you lose sight of

TYPES OF MONGOLIAN MEN

Top: YOUNG MONGOL SHEPHERDS. THE MONGOLS DID NOT FARM; THE REASON WAS THAT THEIR RELIGION FORBADE THEM TO HURT "MOTHER EARTH" THROUGH DIGGING. A GREAT NUMBER OF THEM WERE SHEPHERDS, MANY TENDING LARGE HERDS OF HORSES. *Bottom:* MONGOL GIANT OVER SEVEN FEET TALL FROM THE URGA REGION; ACROMEGALIC. GOOD-NATURED BUT NOT VERY INTELLIGENT.

him. One wonders if history, which paints them so fierce, can be correct. But they are still the inveterate old nomads. One passes a whole village of their yurtas to-day—and in a few days, returning, finds nothing but a barren ground that just shows where the camp stood. The whole aggregation one day had been loaded on the carts and moved away to better conditions. There are no permanent family habitations, and the Mongol does not till the soil—it would, according to his lamaism, "hurt mother earth to plow it or dig into it." So whatever agriculture there is is in the hands of the Chinese and a few Russians, as are trade and manufactures. The Mongol is the lord of the wastes, with his horses, sheep and cattle. He is not even much of a hunter, for that too is against his religion. Yet he is not free—is under the yoke of the lamas on one side and his own "rich" on the other. . . .

At last reach Urga, the "capital" of Mongolia, and a strange sight meets us. Also, in the outskirts, rather foul air in places—learn it is the smell of what remains of the bodies that are brought out, whenever there is death, for "burial by animals."

Urga lies in a large shallow alluvial depression, above the Tola River. It is a conglomerate of Mongol monasteries, Mongol yurtas, a few Russian houses and a quarter of Chinese dwellings. It is separated into four parts, which are from west to east, the principal monastery; "Kirin" or native town, with another monastery; the Chinese quarter; and the scattering of Russian houses. In addition to which there are two large long market squares; two outside enclosures with gaudy palaces of the chief Mongol religious authorities; the Russian consulate, hospital and barracks; the old Chinese trading town or "Maimatzen." And in the native parts hundreds of mangy dogs and curs on the excessively dirty streets, and refuse heaps. The heterogeneous compound extends for about four miles in length from east to west and for about a mile and a half in maximum breadth, at some distance from the river. The stream itself skirts a long wooded "holy mountain" just to the south of it—an open-air menagerie and a general reservation. The town has usually about sixteen thousand inhabitants, and is surrounded by hills, the nearer slopes of which I became quite acquainted with before long in search for skeletal remains.

The long mountain-ridge beyond the river is sacred; no one must cut any wood there or kill any animals. It is a real natural law-protected zoo of the chief lama ruler, and is said to be stocked with bear, deer and other creatures.

We stopped in the Kirin section, found soon a nice room in a Russian house, and there before long I had fixed my photographic apparatus and, under the floor, a dark room. My plates, for a wonder, with all the knockings they got over the rough roads, came unbroken. I engaged as help a few of the natives and the subjects were brought to me. The Mongols here too were found generally good-natured and they knew of photography, yet it was quite difficult to get some of the best types and often impossible; nevertheless, in the course of the twelve days of my stay I was able to use up all my plates and films, and make many observations.

But all the time while in Urga I had to fight a cold brought from the trip and it was necessary to sleep on the floor with the chill from the moist low earth cellar underneath penetrating through the boards, and to breathe a lot of dust every time one went out of the house, so that the nose and throat and heat got better but slowly. Wanted to write, but it was out of the question. A letter home was commenced four times. When the day work was over there was some time, but had to go out into the hills and gullies

VISITING LAMAS FROM TIBET

to collect skulls until too dark to see, then take them around the town to the distant Russian hospital, come home late, have a bite, and get into the blankets. Uncertainty of work—now a rush, now tedious waiting; the disturbed head; unwillingness of the driver, who did not fancy the task of going with me to collect

MONGOL WOMEN BEATING WOOL IN PREPARATION FOR ITS UTILIZATION

specimens, many of which still smelled badly, and other difficulties, made a coherent recording of things impossible. . . .

The collection of skeletal material here proved almost as grim as that ten years ago on the Yaqui battlefield in Sonora. There were as near as could be found out about 600 deaths a year at Urga. Of these none were buried except the whites and the Chinamen. With the Mongols a body must not be introduced into the earth, it would offend and pollute. So when there is a dead one they place him, without clothes, in the early morning, on one of their crude flat cars, drive into the foothills, then without daring to look behind lash the horses into a gallop over stones and hollows until they feel the body drop in the place of its "choice"; and then without a glance back ride as hard as possible to where they came from. The car from the start had been followed by dogs, and soon there would be also kites and ravens and perhaps a wolf or more converging to the group, to pounce upon the body the moment it dropped and tear and devour and snarl and fight, until not a vestige is left of the young, and but the skull with a few scattered remnants of the hardest parts of the long bones of the adults. Often the dogs would bring parts of the limbs, and even a head, onto the dirt piles within the town itself, as I saw amply with my own eyes; and the ugly mangy dogs in general would return after their feast to town, to spend the rest of the day lying lazily about. Gruesome—but all "as it should be" according to the teachings of the guileful lamas. What perversions possible under guise of "religion." . . .

Strangely, the heads of the adults, while deprived by the beasts of all flesh, would be left almost as they were, to remain in the gullies and over the slopes until carried away by water or ice. And it was these skulls that I was anxious to secure, for they would be of prime importance in connection not only with the study of the Mongols but also with that of the mongoloid affinities of the American Indian. There was thus a sufficient aim and cause and the rest needed only care not to be seen by the Mongols, and endurance of the conditions.

Being a medical man helped much with the work. But a good many of the specimens found were more or less recent. Quite a few still had the brains in. And many such smelled unendurably almost, except perhaps to one used to dissection and autopsies. Even thus, however, it was necessary time and again to remind oneself of the indispensable need of the collection.

The first night tried with our driver, who followed me with his cart—but this almost ended catastrophically, for he got sick from the sights and heavy smell, and was frantic even the next day when he found that no amount of washing would quite do away with the remains of the odor in the wagon. No money I could offer would induce him to go again.

Meanwhile I had made friends with the principal Russians, including the military and their hospital, and the latter came to my aid. The hospital, isolated in the outskirts of the town and near the small Military Post, had a deep yard and at its end in one of the corners a shed. Seeing my dilemma they gave me two mixblood Cossacks and a servant, and loaned me a big iron pot. We then dug near the far end of the yard a big hole in the ground, made fire there, suspended the pot over, and here day and night henceforth one or two of the men would attend to the boiling of the specimens—while one or two would go with me every evening over the grounds and carry the skulls I gathered in a bag. Towards the last, when finds were getting scarce, there was so much ground to cover and the men knew so well what to do, they would go alone, besides my-

TYPES OF MEN FROM CENTER OUTER MONGOLIA

Top: BEARDS OF THE SORT WHICH THIS MONGOL WEARS ARE NOT RARE AMONG THE OLD MEN OF THIS REGION. NOTE THE DEFORMED RIGHT EAR (CONGENITAL MALFORMATION). *Bottom:* MEN TYPICAL OF THE CENTRAL PART OF OUTER MONGOLIA.

TWO TYPICAL MARRIED MONGOLIAN WOMEN
ABOUT THIRTY YEARS OF AGE AND IN THEIR "SUNDAY" DRESSES.

self, and collect. How they bore to carry the sacks on their backs was a wonder. I could not even walk very near to them. And there was the constant apprehension—did not know how the lamas would take it. But there were the understanding good Russians. . . . Luckily the grounds were not very close to the outermost yurtas, the dogs were too lazy and dull to mind anything that was out of their schedule, and the Mongols were doubtless very shy of the places we roamed over; so that all ended satisfactorily.

The boiling and cleaning, in which even the hospital felchar (male nurse acting as doctor where real doctor could not be had) occasionally assisted, proceeded ceaselessly until the whole precious material was in good condition. There were 213 skulls, with but very few of any account left about Urga. They were ranged on planks in the shed —but they still smelled. So a good amount of permanganate of potash was obtained and they were steeped in a strong solution—yet on drying they continued smelling. Then I had a Chinaman make me a lot of small boxes and packed the specimens in charcoal, which could be had here; some months afterwards the boxes were opened in the National Museum at Washington—and the skulls still smelled. It was the brains. . . .

Can never thank enough the Russians. No people could have been more genuinely helpful, and that not only at Urga. After I showed them my Imperial Geographic Society paper not one, even on the guarded boundary, ever asked me for another document. The official permissions, which eventually reached me after such a bother in St. Petersburg, were never taken out of their envelopes. At Urga the Russians not only helped me with the work on the living, with seeing what was worthwhile in and about the town, and with the very great favor at the hospital, but when all was done and

INDIAN-LIKE MONGOL WOMAN AND HER FAMILY
THEY ARE STANDING IN FRONT OF A *yurta* IN WHICH THE AUTHOR SPENT A NIGHT.

packed they sent out all the collections and plates, in one-pood (36 lb.) boxes, without a cent's expense, though first-class mails, to St. Petersburg. I wanted to help all I could in the sending, and at the same time feel sure that nothing happened to the hard-earned collections before they got out of Mongolia; so engaged two additional Russian wagons, took everything along, and after five days delivered everything safe to the postal authorities at Kiakhta.

This is a very rough and imperfect sketch of the doings in Mongolia. What shall I say more—how I saw one whole afternoon a great open-air barbaric Mongol religious ceremony at one of the monasteries, with about six thousand Mongols in attendance; where with grotesque masks and strange costumes they revived Kublai Khan and others of their history; where in one "scene" the trumpets of the lamas were thigh bones of virgins; where transfigured lamas in heavy accoutrements danced or combatted until falling from exhaustion. Or how the Mongols—the best horsemen and horsewomen probably in the world—raced home, horses with wild riders falling here and there and always rising and galloping again, while our "horned-toad" galloped madly with us in his "tarantas" over holes and gullies? How cold drizzling rain tortured on our return? How on coming to Kiakhta, with more money spent than calculated and barely enough left for local expenses, I was told at the only little bank there that they could change no money and how Colonel Chytrovo and later, at Verchni Udinsk and Irkutsk, other high-minded Russians, helped me along until I had what was needed? Yet there are a few little incidents that may deserve a special mention.

One day went to the sacred mountain. Crossed the fair-sized river over a bridge and walked a distance over the wooded and grassy lower slopes. No one at all

anywhere. Some tarbagans (marmots) scampering to their hollows. Soon after a deer—stands at a distance and just looks. Dare not alone go deep for the bears. A strange caprice of the chief lamas this "sacred" zoo and mountain. But they are not savages. Like the monks in the dark ages they carry on a certain degree of culture. They read and write five dialects, and there is published by them even a sort of periodical of which I saw a number. . . .

At Urga, of an evening, late in my room, after a hard day's work. Suddenly hear a song—and in a moment feel as if transposed to some of our Indians. Can not make out the words, but the tune and all about the song is so thoroughly Indian that for a while am uncertain as to where I am. It was a young Mongol and he has now disappeared behind some yurtas, yet I still hear that Indian refrain. . . .

Visiting in a Russian house. Have much to do every night to get rid of the smell of the skulls so no one objects, but have things to work with and so change. A stranger arrives from eastern Mongolia. Is a Swede of about 40 and has been selling Bibles, printed in Mongol, to the natives. There are, I learn, some Missions. The man looks rugged and not very opulent. But of all the occupations a strong man selling Bibles to the Mongolians strikes as about the queerest. . . .

A pass over a range of mountains. A large high pile of small stones at most elevated spot—strangely familiar—have seen the same thing in the Hopi region, except that here there are a few light poles projecting at different angles from the pile and from their points flutter now ragged and discolored haidaki—silk-cloth offerings. And on inquiry find the pile has the same meaning as with our Indians. Each Mongol reaching the pass, after the laborious and rather dangerous (for there are bears and even a few tigers here) journey up the mountain, picks up a pebble, moistens it with saliva, rubs with it his tired muscles, raises the pebble up with brief thanks and a prayer, and deposits it on the pile. Same "tired stone heaps" may be met with in the Andes and other mountains of America. . . .

The Chinese at Urga are making a giant copper Budha for the local monasteries. It is to be about 90 feet high. The whole work is carried on, largely in the open, in primitive ways and very slowly, yet effectively. The ingenious Chinese workers can not but be admired; and quite a few of their tools are very much like those I used to see in my childhood in central Europe—wonder which were the original. . . .

The Mongol lamas make, and sell cheap, remarkable intricate religious paintings in which a fine deep cobalt blue is most conspicuous. Some of these products are real pieces of art. Regret I did not get a whole collection. . . .

On the main "square" in Urga. At an old wall, seated on a sort of low platform, a female bard, of perhaps 50, interesting face, a quaint sort of a guitar. Sings and accompanies herself on the instrument. Sings very different from that man that night—almost as in the Balkans. A small crowd of Mongols about her and copper coins are given to the singer. Listen to her and watch her with much pleasure and gladly give also, for she is genuine, at times even elated with her own ballad. . . .

Go to see a Chinese house. Astonishing carved decorations even on the outside, though this, for protection, is just a wall with a carved and gaudily painted central gate. Inside find a spacious slab-paved square patio with verandas about it, and on these flowers and cages with birds—as in the better homes of Spain or Latin America.

A BEGGING LAMA CARRYING RELIGIOUS PICTURES RELATING TO LAMAISTIC FAITH

THESE LAMAS USED TO ROAM OVER THE COUNTRYSIDE, LIVING ON THE PEOPLE AND EXACTING AS MUCH TOLL FROM THEM AS THEY COULD POSSIBLY SECURE.

Enter, with F., on a side of the yard, met by a well-groomed prosperous looking young Chinese merchant, in a silk blouse and round dome-shaped silk cap. Invites us smilingly and pleasingly politely to the next room, where we sit on rug-covered little bench-stools, while our host excuses himself only to return in a little while with a male servant bringing hot tea, of which the host partakes with us in all cordiality. Is a merchant, as all the Chinese here, but we only see his "store" after we tell him—he understands a little Russian—that I should like to buy a pound or so of the fine "mandarin" tea of which I have heard. The store is in another part of the house, unnoticeable from outside and without any display of goods. We get what was wanted, pay a fair price, are friendly and not in the least obtrusively conducted out, and part regretting there is not another purchase to make. . . .

Another Chinese house. I was asked to bring home some of the fine white "astrakhan" fur, if obtainable. Find that there is plenty of it here, so desire to buy a skin or two. Go with F. to

WOMAN BARD ON THE MAIN SQUARE IN URGA, MONGOLIA

the largest establishment. Are met by a well-dressed middle-aged Chinaman, who very kindly shows us a great heap of tarbagan furs and another, smaller, of the beautifully curly pelts of the white lambs. That, I tell him, is just what I am after. But he replies with a smile, to my astonishment, that he can not sell any to me. But why—why not sell to me? Want but two or three, though the best ones. No—can not sell. And thus for a while, until he takes one of the furs, passes his palm over it—and shows us on this some hair that has come out. Repeats it with another fur—and then I understand, the skins are not good enough for me, have not been tanned properly, some of their hair will come out when worn. O Diogenes with your lamp, here at last is your honest human! . . .

Going on from the Iro. Sitting in the back of the wagon and killing mosquitoes. There are several varieties and the quantities are inexhaustible here near the river. One species, color of dried leaves and speckled, is especially large and easy to get. Just offer the forearm and the legs and keep on slapping, and when one hand gets tired use the other. Before we reach the higher and freer ground have quite a harvest, and there is some satisfaction. . . .

Near the road a few huts of Russian trappers. Stop with them over night. Several are home, and tell me of many fossil bones, some of huge size, in gorges, in the region, in which they hunt and offer to accompany me to them; but the trip would take a day to go and a day to come back, which I can not spare at this juncture, and there is another reason. This is the country of the Hunhuz. They are said to be mostly former provincial soldiers who had not been paid, and so deserted and try to get whatever was coming to them by banditry. They do not kill unless opposed, but take horses, provisions and valuables. During the night our horses are watched constantly, but nothing happens. . . .

Aug. 26. Once more on the Selenga. 5:15 P.M. The boat leaving the barren shore—good-bye Ust-Kiakhta and what lies beyond. Good-bye for the last time, for I do not expect to return.

Again on the clumsy "Rabotnik," on the swollen river, among the poor hills, but this time sliding speedily down with the current towards the great artery of all these lands, the Trans-Siberian.

The gate to the strange world from which I just emerged is rapidly closing behind, and the last chapter of this year's Odyssey commences, the one of a slow coming home. With two lightened satchels, a blanket, a little bit of a pillow, a holey umbrella and a weather-worn raincoat; with the stomach filled with a liter of good milk, half churned over the last piece of road, and greeting the first swallow since this morning; with the body and eyelids still some weary but nearing the normal; with the brain filled with late gleanings and recollections and contented over the material results of the voyage; and with the heart warm and yearning—so I begin my journey back towards the States, over Europe; it became impracticable to go the other way, over the Pacific. Feel happy again—not exuberantly, or lightly as the lark, but soberly and preciously; like the ship that has recently been much tossed about and now sails slowly into the harbor of its final destination. . . .

Verchni Udinsk. A pioneer city—much like some of our own western towns. Large plate-glass windows to some of the stores, the first seen in Siberia—am told they came by Vladivostok from America. And to complete the picture for the first time see men from the country carrying openly cartridge belts and big pistols. Some shooting in fact during the night. . . .

Arrive at Irkutsk. Have since a week been vexed by lack of Russian money,

MARRIED MONGOL WOMAN
SOME SUCH FINELY DRESSED WOMEN ARE CALLED "PRINCESSES" BY THE MONGOLIANS.

MONGOL WOMAN IN HER FINERY
MUCH OF THE DECORATION IS EXQUISITE SILVER FILIGREE, PROBABLY MADE BY THE CHINESE.

and the French banknotes that were supposed to see me throughout Russia, could not be changed either at Urga or Kiakhta. Had to borrow from Colonel Chytrovo enough to take me to Irkutsk, where there are banks that will surely change me what I need. So get off the train here and walk to the good-sized town over a long low wooden bridge. Everything appears strangely inactive. Reach the main street, which is like in some smaller European town—but here too everything is uncommonly quiet, though it is near ten in the morning. Catch up with a lonely pedestrian, ask him where the nearest bank is—and he informs me this is a "prazdnik" (holiday) and none of the banks will open; not until to-morrow. Ask him where I could change a French note and he can not tell me. A nice how-do-you-do. Have not enough Russian money to even pay for meals. Passing wistfully a large house see in a window sign "Sibir"—a local newspaper, and inside a bearded man working. Decided to turn to him. Go in, find the office, am received civilly and learn the man is F. T. Shiriaiov, editor of the *Journal*. Show him my "open letter" from the Imperial Geographic Society, and tell of my difficulty. He is interested, friendly and asks me to wait a little till he finishes something. Then goes out with me and brings me to a good friend of his, a hotel keeper, and he good-naturedly changes me a hundred franc note without objection, promising more later. We then have a light lunch and my new friend, who is also the secretary of the local branch of the Imperial Geographic Society, takes me to the museum of the society. Find admirable collections, and then am led to the rich library, where on a shelf my friend shows me elatedly a line of the green-bound torch-marked publications of the Smithsonian Institution, including a couple of my own contributions. . . .

Late that afternoon am guest at the house of my new acquaintance. He has a still young pleasant good-looking wife, a fine daughter of 16 and a slightly

younger son. All accept me as they would an old friend. All are musical, and after the enjoyable meal they play and sing, in Russian, wonderfully and wholeheartedly. Must tear myself away with force late in the evening to get to train. Find that my friend was a political exile to Siberia. His punishment was a banishment for a number of years to the Irkutsk district. It seems to me in some such cases the exile would rather have turned out a reward than punishment. But his was a "light" case. Anyway he married locally, established here his permanent home, became the editor of one of the foremost Siberian papers, and is evidently generally esteemed.

September 6. Leaving Siberia—and something almost hurts. Russian America. Thanks to you once more, Mme. Karnakova, Colonel Chytrovo, friend Shiriaiov, and all you Russians, Cossacks and even Chinese at Urga.

Am alone again since some time. F. is returning on the "počtovoi," the mail train, which is much less expensive—though even I am not on the best one. The summer is nearly over, autumn tints prevail, and nights are cold. Many little episodes on the road again. A train crowded to limits with baggage of all sorts and birds in cages, melons on floor, samovars, women, children. A party of overbearing loud Germans at a station—the Russians, shamed, turn away from them. At smaller stops see again and again women with a little child holding the skirts, a younger one on the arm, and another expected. . . . As we cross the Urals, this time more to the south, see many workings in gravel for platinum and precious stones. . . . At a large town beyond they sell articles in jet-black iron, some of which genuine little works of art. . . . Crossing "matushka" Volga over a long bridge—sandy shores, semiarid wastes both sides. . . . Gorgeous treasures at Moscow in the Kremlin palaces. . . . And so on, to the Berezina of Napoleon's disaster, over White Russia to Warsaw, and then across the rest of Europe to England and thence to America. . . .

A few last thoughts to Siberia. A vast country, vast forests, probably great other resources—but near all yet for the future, when there are enough of men, and when men have harnessed and softened nature. But already it is a new,

A BARD AND HIS INSTRUMENT

MEN AND WOMEN BARDS ROAM OVER THE COUNTRY MUCH AS THEY STILL DO IN THE BALKANS.

much freer and stronger Russia, untrammelled largely by the past, forging onward. Country of the hunter, trapper, miner, pioneer in all lines, as used to be and to some extent still is our West. Some day—not soon, yet probably not too far away—it will be the revitalizer of the old Russia; and from it will rise strong men and women, mentally as well as physically. Will be a new human light, and power, a century hence. . . .

SWORDFISHING WITH THE HARPOON IN NEW ENGLAND WATERS. I

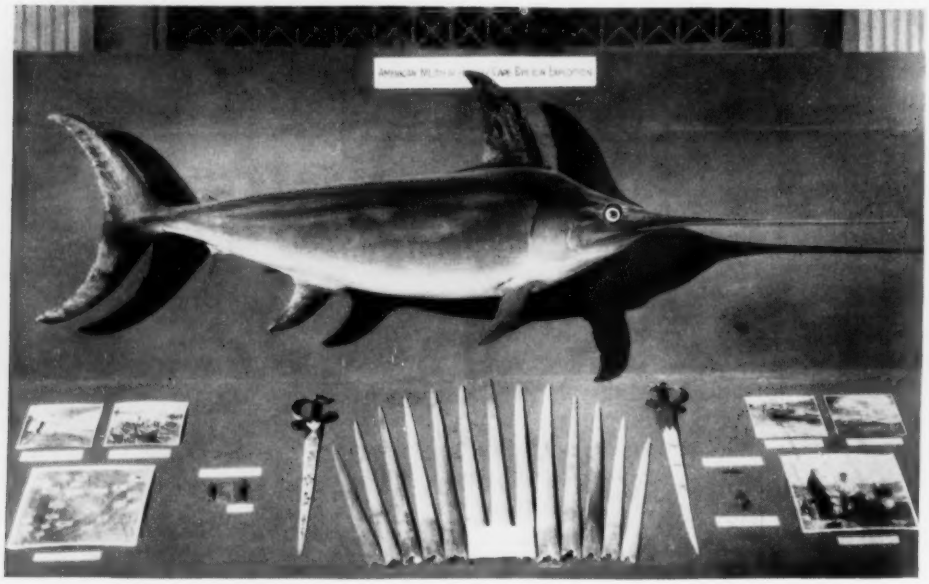
By Dr. E. W. GUDGER

HONORARY ASSOCIATE IN ICHTHYOLOGY, AMERICAN MUSEUM OF NATURAL HISTORY

On a day in July, 1922, I disembarked in New Bedford, Massachusetts, from a steamer from Woods Hole, with a swordfish sword in one hand and a suitcase in the other. After visiting the interesting whaling museum, the pangs of hunger drove me to a restaurant for luncheon. On the bill of fare I read "Swordfish Steak." I had never eaten one, but I decided to remedy that deficiency at once. So presently, with a swordfish sword across my knees, I ate a delicious swordfish steak, in what had at one time been the world's chief swordfishing port. And then and there was begot a desire and determination to study this splendid fish and the methods of taking it.

But alas, many other fishes and many other things occupied my time for years and years. But in the fall of 1936 the Michael Lerner-American Museum Cape Breton Swordfish Expedition returned to the museum with a wealth of swordfish material, not the least interesting being a beautiful skeleton and a barrel of swords. And presently there was prepared the much-admired swordfish exhibit of which the central object is the splendid model of Mr. Lerner's great 601-pounder taken with rod and reel.

In July, 1937, there was sent to me a snapshot photograph showing a swordfish's sword at the very moment it penetrated the side of a fisherman's dory. And a few weeks later there came in a board from the bottom of a dory rammed



DISPLAY IN THE AMERICAN MUSEUM OF NATURAL HISTORY

TROPHIES BROUGHT BACK BY THE AMERICAN MUSEUM-MICHAEL LERNER-CAPE BRETON EXPEDITION IN 1936. THE SWORDFISH IS A MODEL OF THE 601-POUNDER CAUGHT BY MR. LERNER.

by a swordfish off Montauk, Long Island, with the sword still embedded in it.

With these incentives, I went to work studying this most interesting fish, its habits and the methods by which it is taken. Some of the things which I have learned, I have passed on in a short article which may be called a preliminary report[1] on what are apparently retaliatory attacks by the fish on the fisherman's boats. In another and larger paper, I have treated fully the fishing for Xiphias in the Strait of Messina,[2] a region in which the swordfish has been sought from prehistoric times to the present day.

In addition to these studies in the history of swordfishing with its perils and romance, I have made an extensive study of the pugnacity of Xiphias and the spearfishes and have found in the bony structures of skull and spinal column the explanation of how and why they can bury their swords deep in the hull of a wooden vessel without "breaking the neck" or dislocating the spinal column.[3]

And now I am ready to bring the reader to those waters in which the swordfish has been sought for only about three quarters of a century, but in which time the fishery has been raised to an increasingly high degree of efficiency and success. For this general region, and particularly for the offshore waters of New England, there is a great accumulation of interesting data covering 75 years' fishing. But before plunging into the story it will be interesting to set forth the earliest evidences of the occurrence of the swordfish in the Western Atlantic.

[1] *Natural History*, 1938, 41, pp. 128–137, 12 figs.
[2] SCIENTIFIC MONTHLY, 55: 36–46, 8 figs. 1940.
[3] *Memoirs Royal Asiatic Society of Bengal*, 12: 215–315, 9 pls., 22 text-figures. 1940.

Mazzullo, 1906

HARPOONING PESCE SPADA IN STRAIT OF MESSINA

THE LOOKOUT ON THE SHORT MAST HAS LOCATED THE FISH, THE OARSMEN HAVE PUT THE BOAT ONTO THE PREY, AND THE HARPOONER DRIVES HOME THE TRIDENT.

Yachting Publishing Corporation
SWORDFISH AT SURFACE
ON THIS FUNDAMENTAL HABIT OF "FINNING" OR BASKING AT THE SURFACE, THE DETECTION AND HARPOONING OF XIPHIAS HAS BEEN BASED SINCE POLYBIUS'S DAY, ABOUT 100 B.C.

Gloucester Chamber of Commerce
SWORDFISHING SCHOONER
OF ABOUT 1919, WITH A MOTOR AS WELL AS SAILS. NOTE THE THREE MEN ON THE FORE-TOPMAST AND THE STRIKER IN THE PULPIT, THE STEERSMEN AND THE HELPER AT THE WHEEL.

Earliest Records of the Swordfish in the Waters of the New World

On Columbus's first voyage, one of his men on one of the West Indian islands killed a native warrior armed with a swordfish sword—a modern form of which may be seen in the first picture. This sword was taken to Europe and, along with other mementos of his voyage, was deposited by Columbus in the old collegiate church of Siena in northern Italy, where he was educated. In this church, closed for long years and rarely visited by tourists, this sword was seen in 1879 by Colonel N. D. Wilkins of Detroit, Michigan, as reported by G. B. Goode in 1883 in his book on the swordfish.

The other account is the first published record (1675) of the occurrence of the swordfish and of its assault on a vessel in the Western Atlantic. This is interesting in itself and because it is the

Charles H. Coles
A MODERN BRONZE HARPOON HEAD OR "LILY IRON"
THE DOTTED OUTLINE SHOWS THE RECEPTACLE FOR THE POINT OF THE IRON SHANK. THE LINE IS FASTENED THROUGH THE HOLE. THE WINGS SECURE THE HARPOON IN THE FLESH, AND SOMETIMES THE HEAD GOES THROUGH THE FISH'S BODY AND ACTS AS A "TOGGLE."

H. C. Raven

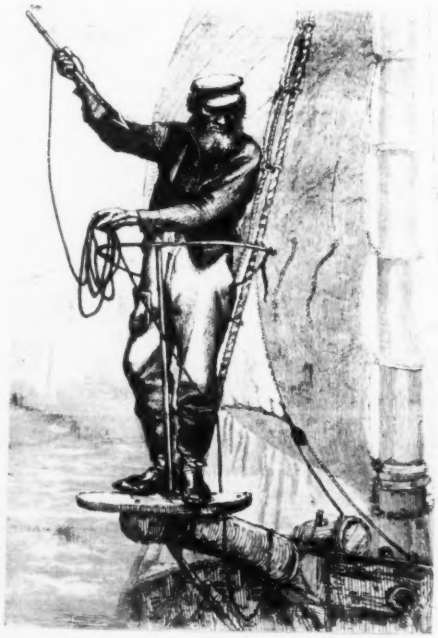
A SWORDFISHING BOAT

WITH AN ENGINE, A "PULPIT," AND A MAST. THE LOOKOUT STEERS WITH LINES RUNNING UP THE MAST; THE ENGINEER HARPOONS.

Yachting Publishing Corporation

A LEAPING SWORDFISH

XIPHIAS LEAPS TO FREE HIMSELF FROM SHARK-SUCKERS OR IN SHEER EXUBERANCE.



Harper's Weekly, 1879

EARLY HARPOON-FISHING

THE EARLIEST PUBLISHED FIGURE (1879) OF HARPOON-FISHING FOR XIPHIAS IN UNITED STATES WATERS. HERE THE GRIZZLED HARPOONER STANDS IN THE PULPIT READY TO DRIVE HOME HIS SHORT-SHAFTED SIMPLE DART.

R. I. Nesmith

SCHOONER FORE-TOPMAST

THE FORE-TOPMAST OF A PRESENT-DAY SWORDFISHING SCHOONER HAS FIVE LOOKOUTS TO SCAN THE WIDE SEA. EACH HAS A DEEP-VISORED CAP TO PROTECT HIS EYES FROM THE SUN, AND IS ANCHORED TO THE RIGGING BY A WINDOW-CLEANER'S BELT WHICH LEAVES HIS HANDS FREE—ESPECIALLY WHEN THE VESSEL ROLLS.

fourth of the earliest accounts of attacks on vessels by the swordfish.

John Josselyn and a number of associates left Gravesend, England, on April 26, 1638, for what is now New England. On June 20, while "upon the bank of New-found-land," they had an interesting adventure, which Josselyn narrates as follows: ". . . in the afternoon [of June 20, 1638] we saw a great fish called the *vehuella* or Sword fish, having a long, strong and sharp finn like a sword-blade on the top of its head, with which he pierced our Ship, and broke it off with striving to get loose. One of our Sailers dived and brought it aboard."

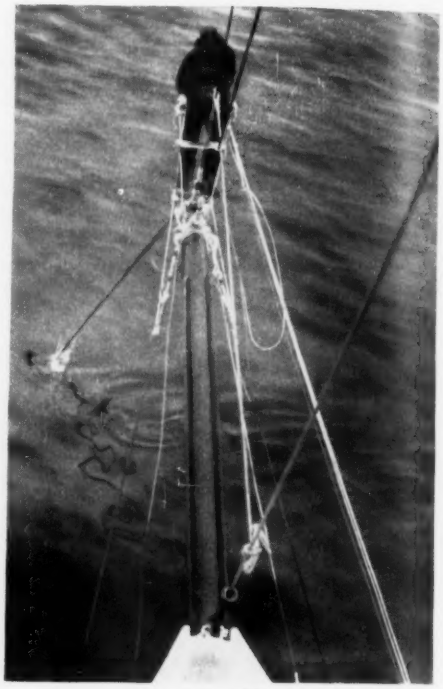
Swordfishing Grounds of the Western North Atlantic

Let us now get a bird's-eye view of the swordfishing grounds of the Western North Atlantic. These (p. 424) include the comparatively shallow coastal waters and banks from northern Long Island to Newfoundland, but especially the following banks off the New England coast: Georges, Browns and Le Have. In these shallow waters, shoals of mackerel, menhaden, herring, etc., abound, and here the swordfish are found feeding on these fishes.

Gloucester Chamber of Commerce

STRIKER IN ACTION

FROM A PRESENT-DAY PULPIT, SECURED TO TWO TIMBERS LASHED TO THE BOWSPRIT. EVERYTHING IS REMOVABLE AT END OF HARPOONING SEASON.



Gloucester Chamber of Commerce

SWORDFISH MAKES OFF

THE STRIKER RETRIEVES THE POLE OF HIS HARPOON FROM THE STRICKEN FISH BY THE ATTACHED WARP, AND THE DISILLUSIONED FISH TRIES TO ESCAPE BUT IS TETHERED TO THE BOAT BY THE LONG HARPOON LINE.

In the past seventy-five years, swordfishing in New England and Nova Scotian waters has become an occupation of considerable commercial importance. For instance, in the "high year," 1929, 6,069,000 pounds of swordfish were brought in to New England ports alone and sold for $908,500. Unfortunately the number of fish taken is not stated.

but if three hundred pounds is agreed on as the average weight of a dressed swordfish, then about 20,250 fish were brought in this season. In the course of these seventy-five years' fishing, many vessels and dories have been rammed by Xiphias, and occasionally a fisherman has been hurt.

Since I have little data for Nova Scotian fishing, this will be considered first and then attention will be directed to the far better developed New England fishing.

Harpooning Xiphias Off Nova Scotia

How long swordfishing has been carried on in Nova Scotian waters, I can not say. The methods employed are essentially like those used by New England fishermen, but they do not seem to have been developed to the same high point. I have not found any accounts whatever of retaliatory (?) attacks on the boats of the fishermen in these waters, though they probably still occur. Many accounts of such attacks in New England waters will be given later.

I do not have the numbers and weights of swordfish brought into Nova Scotian ports for any year nor for a term of years. But for the port of Louisburg in 1937, the year of the first Michael Lerner-American Museum Swordfish Expedition to Cape Breton, Nichols and La Monte say that it is a swordfishing town of importance and that while they were there—July 28 to August 25, 1937—a good day's catch amounted to over three hundred fish. At an average weight of three hundred pounds per fish, this would mean over 90,000 pounds landed in this one port alone in one day. Probably the total for all the fishing ports in Nova Scotia would be many times that for Louisburg for a season. However, it needs to be said that 1937 was an unusually favorable year.

The boats used for swordfishing out of Louisburg are small gasoline launches, twenty-five or thirty feet long, powered with automobile engines adapted to the purpose. The launch has in the center a mast about sixteen feet high for the lookout. This reminds one strongly of the masts in the Italian boats used in swordfishing. In the article on fishing for Xiphias in the Strait of Messina, it is shown that rowers, not gasoline engines, furnish the motive powers. With these Italian boats, however, the fishing is done close inshore—in the Strait of Messina. The pulpit, or rest, of the Nova Scotia boat is at the end of a ladder-shaped structure (the boats have no bowsprits) bolted to the deck and easily removable when not needed. This rest, at the prow of a plunging small launch in a swell, offers at best an uncertain stand for harpooning Xiphias.

The crew consists of at most three men —engineer, lookout and striker. Very often there are only two men—the lookout, who has lines at the masthead by which he steers the boat, and the engineer-harpooner, who goes forward to the pulpit when a fish is seen. Seeking the fish, these little launches may go as far as twenty-five miles off shore. The swordfish are harpooned, allowed to tire themselves out, then hauled up to the boat and dispatched. The catch for a trip may run from two or three to six or seven fish, but these latter catches are exceptional. This fishing is rather primitive and the catches small compared to what will be found when New England boats and fishing are described.

Harpooning the Swordfish in New England Waters

In the shallow waters from Long Island to Newfoundland, the swordfish, seeking his herring or mackerel prey, sometimes gets ignominiously entangled in a net. Sometimes he gets caught on trawl-fishermen's deep-set hooks, but predominantly he is taken by the har-

poon method, and to this we will now turn attention.

In New England waters, as off the Calabrian coast, Xiphias is harpooned. In both regions the harpoon-technique is based on two habits of the fish—his basking at the surface and his leaping or "breaching." These two habits of "finning" and leaping are fundamental characteristics of Xiphias. And, since they are the characteristics that make his harpooning possible and profitable, they deserve further description.

The "Finning" Swordfish.—On calm, warm, sunny days, Xiphias loafs at the surface with the upper part of the dorsal and caudal fins, and sometimes part of his back, out of water. He seems to be sunning himself, as old Polybius recorded the fact more than two thousand years ago. Such "finning" (and more seldom leaping) fish are easily discernible to keen-eyed lookouts on the mastheads of "sworders" and the vessels are headed for them. My invaluable swordfishing correspondent, Mr. Wm. H. Hand, Jr., naval architect, of New Bedford, Mass., who has personally harpooned over five hundred swordfish in his twenty-five years' experience, tells me that the finning fish swim in great irregular circles and that the lookouts try to guide the boats so as to intersect the orbit of a given fish.

Why the Swordfish Leaps.—It is common belief that the swordfish leaps to shake off parasitic crustacea and to free itself of its commensal suckerfishes (the Echeneids). Aristotle (384–322 B.C.) was the first to describe its leaping. He wrote that, "So acute is the pain it (the parasite) inflicts that the swordfish will often leap as high out of the water as a dolphin; in fact it sometimes leaps over the bulwarks of a vessel and falls back on the deck."

The suckerfishes attach themselves to the swordfish and are carried about by their host. When the host slashes about with his sword in a school of small fish, the suckers (commensals) let go, swim about, feed on the fragments and then return to their home. This external adhesion would seem to cause little annoyance, but when the "suckers" penetrate the gill-chamber, their favorite haunt, they must become exceedingly annoying.

Whatever its cause, whether to free the fish of parasites or in sheer exuber-

THE FISHING BANKS OF THE NORTHWESTERN ATLANTIC

ON THIS CHART ARE SHOWN THE SWORDFISHING GROUNDS FROM LONG ISLAND ON THE LEFT TO THE GRAND BANK OF NEWFOUNDLAND ON THE RIGHT.

ance, such a leap may end in a beautiful arc and a quiet disappearance in the water, or in an abrupt fall and a resounding splash. But in either case the leaping fish is visible at a far greater distance than the "finner" and will probably catch the attention of a lynx-eyed lookout on the topmast of a prowling sworder and lead to the undoing of the ocean warrior with the trenchant blade.

Harpooning from Rowboats

In Mediterranean waters swordfishing has always been and is to-day carried on from small boats (p. 419). In New England water such boats have been used sparingly, due among other things to the fact that for some reason or other the New England swordfish seems afraid of a small boat, but not of a schooner.

About 1885 some fishing was done out of Saco, Maine, in small boats, apparently about the size of those figured from the Strait of Messina. One schooner is said to have carried a whaleboat rigged out for striking and holding the fish. A swordfish would quickly tire himself hauling such a heavy boat about. This fishing could be carried on only in calm weather and it is subject to three serious handicaps.

First is the small radius of vision of the harpooner in the low bow of the boat. Then there is the difficulty of approaching Xiphias in a small boat, of which all hands agree that that fish in our waters is afraid. And third, there is the difficulty of making a hard and successful stroke of the harpoon from the necessarily low position.

The latest published record (1887) of harpooning from a small boat is from Ipswich, Mass. The fatal termination of this fishing will be recited later. This seems to have been an isolated case and the practice has died out. This is confirmed by Mr. Hand, who writes that "I have heard of fish being harpooned from dories away back in the old days before swordfishing vessels were equipped with auxiliary power. Fishermen, who have told me about it, indicated that the attempts to catch the fish this way almost always failed."

Harpooning from the "Pulpits" of Schooners, 1870–1899

Commercial swordfishing in New England became fairly well established about 1850, and by about 1870 the procedure of harpooning from the bowsprit of a schooner, sloop or smack—all with sails—had become pretty well standardized. In this fishing, advantage was taken not merely of the habits of finning and leaping, which proclaimed the presence of the fish, but of another prime characteristic. This is the fact that, like the dolphin (mammal, not fish), Xiphias seems to find nothing to fear in a bucking, plunging schooner with some freeboard, but unhesitatingly allows it to approach near enough—until the bowsprit is over it—for the harpooner to make his thrust. However, though the swordfish seems almost to play around the vessel's bow, it never allows the forefoot to strike it but always turns aside in time, often like the playful dolphin but sometimes like a surly dog who is not afraid but who nevertheless grudgingly gets out of the way. On this matter Mr. Hand tells me that the larger the vessel, the more closely will the fish allow it to approach. But he has noticed that Xiphias seems definitely to avoid boats and smaller vessels, possibly considering them as enemies.

The earliest account and figure known to me of swordfishing in the western world is found in *Harper's Weekly* for 1879. This short anonymous account, possibly written by G. B. Goode, does not differ from that to follow, but the figure, because of its historical interest, is reproduced herein on p. 421. It

antedates all other figures of swordfishing in our waters. Here the grizzled harpooner in his stand on the end of the bowsprit holds midway of its short shaft not a harpoon but a dart. The figure which appeared but four years later is quite different and authentic (p. 428). The artist must (for the harpoon at least) have drawn not on the facts but on his imagination.

That the reader may understand the *modus operandi* of commercial swordfishing as carried on from a regular swordfishing schooner of fifty tons or less in New England waters from about 1880 to 1899, a figure and descriptions will now be introduced. These are taken from George Brown Goode's splendid brochure, "Materials for a History of the Swordfishes," published in the Eighth Report of the United States Commissioner of Fish and Fisheries in 1883.

Swordfish were harpooned from the bowsprits of schooners, but unfortunately no figure of such an entire vessel is available. The essential persons were the lookout on the masthead, the steersmen at the wheel and the striker in the "pulpit." This man, on the end of the bowsprit, with his harpoon and the line extending back to the keg or buoy, was the vital factor in the fishing. He and his apparatus are all well shown on page 428.

The "pulpit" or rest was a small wooden platform at the end of the bowsprit for the harpooner to stand on, together with an iron hoop or support about waist high for him to lean against. This hoop was welded or riveted to the upper end of a stout iron rod, whose lower extremity was expanded into a ring which was shrunk and possibly bolted onto the very outer end of the bowsprit. Without this rest it would have been practically impossible for the striker to steady himself enough to harpoon the fish in weather other than a calm.

The make-up of the harpoon is shown on p. 428. The handle was in early days a pole of hard wood with the bark left on it to give the striker a good grip. The lower end was pointed and fitted into the socket at the inner end of an iron shank and secured to it by screws or spikes. On the slender outer end of the shank was fitted securely the detachable barbed harpoon head or "swordfish iron." From the harpoon head a line ran along the pole to the hand of the striker on the end of the pole. This line was generally about one hundred fathoms long and at its inner end was attached to a keg or buoy. Not shown was a light line or warp by which the harpooner regained the pole with the attached harpoon shank when it and the shank became detached from the harpoon head embedded in the swordfish. The entire weight of pole, shank and head, was about fifteen or sixteen pounds.

The harpoon head or "swordfish iron" or "lily iron" is not well shown on page 428, and no figure of it alone seems to have been published. To-day the "iron" used is a replica of that of Goode's day. However, it is no longer made of iron but of cast bronze, since this is not affected by salt water. The outer end of the central shaft has two wings, each flaring off at an angle of about 30°. Just below their point of junction is a round hole for the reception of the point of the harpoon shank. At the other extremity are the paired barbs of the harpoon proper. In the middle is the transverse hole for attachment of the harpoon line.

When this dart-head is driven into the fish and the pole withdrawn, the pull on the line makes both sets of barbs catch in the flesh. In fact, as the fish tows line and keg about, the whole dart-head tends to take a position in the flesh at right angles to the pull of the line exerted in the middle of the dart. The whole dart-head then becomes an effec-

tual "toggle," securely holding the fish. This is particularly true when, as sometimes happens, the harpoon head is driven clear through the fish.

Now it is plain that the success of this harpoon-fishing depended on the close cooperation of at least three men—the lookout aloft, the steersman at the wheel and the striker in the pulpit. The boat might have been sailing along over the "sapphire sea" with all the men "taking it easy" save the mastheader, who ceaselessly scanned the sea beneath him. When he saw a basking swordfish in the distance, his cry, "Swordfish!" brought all to active life. By shouts and gestures he directed the steersman how to head for the fish. But when close at hand the harpooner helped to guide the man at the wheel to "put him onto the fish."

This is a fine sea picture: the schooner under a bright sun on a calm sea, the mastheader watching for a finning or leaping swordfish and by his excited gestures and shouts directing the steersman how to follow the fish, and the alert striker in the pulpit eager to harpoon the prey.

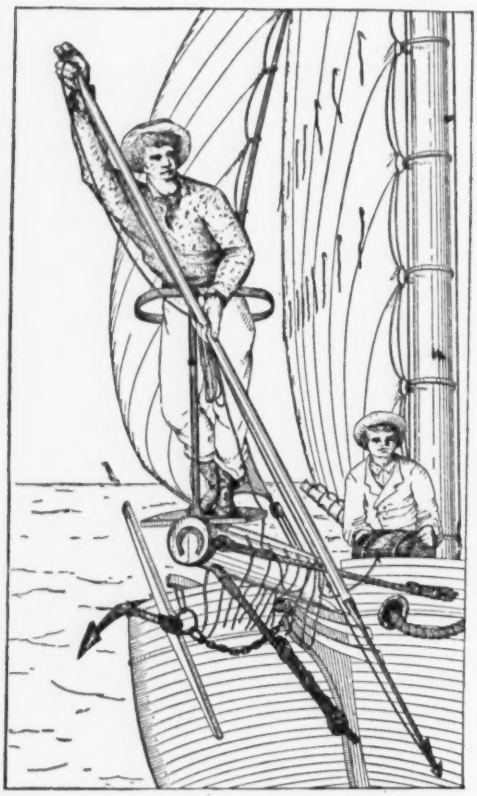
The harpoon was not thrown or "pitch-poled" at the swordfish, as it is at a whale, but, with the pole held in the hands, the harpoon head was driven into the fish's back. Xiphias was "punched," in the swordfisher's parlance. The fish then darted off, the pole and shank were withdrawn from the socket in the "iron" and retrieved by the attached warp. The man holding the keg, with the line from the harpoon head to it, allowed the line (about 100 fathoms long) to run out and threw the keg overboard. The haltered fish was next allowed to tire itself out, dragging the long sagging line with its keg hither and yon; "to wear itself out with its own agitations," as one writer quaintly put it. The mastheader kept the keg in sight and presently one or two men were sent out in a small boat to retrieve the keg, to haul in the line and to bring boat and fish so close together that the fish could be killed by lance thrusts in its gills and then brought to the schooner.

Swordfish Harpooning, 1900–1940

The method of taking the swordfish is still by the harpoon, but the day of dependence by New England swordfishermen on small schooners, sloops, etc., activated by sails alone, is long over. The fairly large schooners of to-day still have sails, which serve to steady the ship against rolling, to carry her on in case the motor balks, and in a strong gale to help the motor drive her. But gasoline and more lately Diesel engines carry the boats through storms, tide them over emergencies, and on the Banks put them quickly on the fish.

Present-day apparatus is essentially as shown on page 428, even to the keg. The pulpit, however, is generally of heavier construction. A "sworder" of 1915–20 is shown on p. 420. The top of the foremast is given over to the lookouts—here three in number—the striker is in the pulpit, the steersman at the wheel.

I have sought far and wide for a broadside view of a present-day swordfisherman—but in vain. However, I have a splendid picture of a foretopmast with five lookouts, like a group of gigantic birds (page 421). These lookouts are in three tiers, and below is room for two more. These five (sometimes seven) men, with wide-visored caps, are needed because of the intense glare from the water, which calls for more eyes and which would make it hard for one or even two men to watch the whole wide mirror of the sea below them; because the greater speed of the motor-driven boat over the old-timer enables her to cover far more territory; and finally because (as Mr. Hand states) the swordfish tend to swim in wide irregular circles. In directing the steersman (who can not see the quarry) how to turn and dodge



Goode, 1883

HARPOONING IN NEW ENGLAND

THE *modus operandi* OF HARPOONING XIPHIAS OFF NEW ENGLAND SHORES IN THE LATE 1800'S. THE HARPOONER STANDS IN THE PULPIT AT THE END OF THE BOWSPRIT, HOLDING A LONG-HANDLED HARPOON, TO WHICH IS ATTACHED A LONG LINE WITH A KEG OR BUOY AT ITS INNER END.

to enable the boat to cut the arcs of not one but several fish, the lookouts must develop an excellent judgment of angles and distances and speeds. The lookout's job on a modern motor-driven sworder certainly has developed into a fine art. As a result of all these factors, many more swordfish are harpooned than in the old days of slow-sailing schooners with only one or two lookouts.

All this is very fine on a quiet day—the bright sun, the mirror-like sea, the finning and leaping warriors of the deep. But because the men are sixty or seventy feet above the water, on even a moderately rough day they are subject to tremendous and very unromantic rolling. On the point Mr. Hand writes about, "Ideal swordfishing weather is, of course, the finest weather with the smoothest sea, but the professionals continue to fish frequently when the weather is quite bad, and then the rolling in some cases goes through an arc of 60°. But ordinary (not excessive) rolling bothers the mastheaders comparatively little; it is the pitching that gets them." To give the lookout men more security than that of the grasp of their hands, and to leave their hands somewhat free, they are secured to the rigging by belts such as window cleaners use.

In the picture note that the wooden platform is secured to timbers which are lashed fast to the bowsprit. Thus when the swordfishing season is over, the pulpit and supporting timbers may be removed *in toto* and the unhampered vessel put in shape for seeking cod, halibut, mackerel, etc. From foot-rest and timbers, iron supports extend upward and have at their outer ends a three-quarter circle of iron to support the harpooner when in action. There is a swinging seat in the open rear part of the circle and, when the boat is cruising around, the striker sits thereon and "takes it easy" until a fish is sighted.

The fish heeds not the approaching schooner but turns a great and unsuspicious eye upward, ignorant of impending doom. On the boat all are on the *qui vive*, as the striker, with tense arm and calculating eye, drives the iron into the back of Xiphias. "Good iron, that!" the skipper calls out, as the disillusioned fish makes off. The shaft is retrieved by the upper line; when the harpoon line has about run out, the keg is tossed overboard. It acts like the "drogue" on the wheelman's harpoon line, and it also enables the lookouts to follow the erratic course of the stricken fish.

These larger and improved "sworders" with Diesel engines, when compared with the old-time sail-driven boats, are not only speedier but are more easily maneuvered to put the striker on the fish. Then with a masthead full of keen-eyed lookouts, many more swordfish than formerly will surely be taken. Thus, according to R. C. Osburn, 684 fish were brought into Boston's T-wharf in one day, 707 on another day, while one schooner brought in 202 from one "trip." The year 1929 was "high catch" for all time to date in New England—6,069,000 pounds of swordfish were brought into various ports during the season.

From this mere sample of the statistics of the New England swordfishing for one year, one may get some small idea of the growing density of commercial swordfishing in these waters over the past seventy-five years. This will give the reader a background against which to expect a large number of (retaliatory?) attacks by the fish on fishing boats large and small. There must have been hundreds if not thousands of such attacks, but the fishermen take them as a matter of course and comparatively few have been recorded.

Dangers from Harpooning Swordfish in New England Waters

The harpoon method of taking the swordfish in New England waters has been given and the romantic aspects of the fishing have been pointed out. Now the other side of the picture, the dangers of this harpoon fishing, will next be considered. Undoubtedly hundreds of attacks by the fish have taken place, but of these only a few have been recorded and of the published accounts only those will be quoted which particularly illustrate the perils to the fisherman.

As has been shown above, from the time of Polybius (*circa* 100 B.C.) to the present, belief in the pugnacity and vindictiveness of Xiphias has been widespread. In another paper I have considered at length the matter of the alleged pugnacity of our fish as shown in attacks on vessels all over the seven seas. Just here attention will be given to attacks on schooners and their dories in the New England region. Later this alleged ferocity will be studied in the light of the psychology of the fish and an effort will be made to get at the facts.

Schooners Rammed.—The swordfish is an active and powerful antagonist and apparently no respecter of wooden vessels. There have been published many accounts of his attacks all along our North Atlantic coast. But herein our attention will be confined to accounts of attacks on swordfishing vessels off New England, which have been frequent. Thus one captain reported three swords stuck in the planking of his vessel. Another vessel is reported as having eight swords in her hull at the end of a season. And another was struck twenty times in the course of one summer. If all these swords had remained fast in the hulls of these vessels, then when October came the schooners might well have been denominated "swordfish pincushions." When the sword is driven into a seam between two planks, leaks are likely to result.

Swordfish attacks on fishing vessels may be delivered on any part of the vessel. Thus there is a record of a Xiphias which drove its sword into the schooner's rudder. But since we are dealing here with perilous attacks, the accounts to be quoted will be confined to those of rammings of the bows of vessels, since here there is danger to the fishermen in the forecastles.

Schooners Struck in the Bow.—Since Xiphias is harpooned from the bowsprit and, until the keg is thrown overboard, is tethered to the bow of the vessel, it would seem that he would deliver most of his attacks to that part of the schooner.

Thus it is reported that one such harpooned fish, when brought to where he could see the splash of water around the forefoot, turned and rammed the bow just below the water-line.

Here are some other accounts of attacks on the bows of schooners. Thus when a swordfisherman went down into the forecastle in the bow of his schooner to get his suitcase out of his bunk, he found it stuck there—pinned fast by a sword driven through the hull. Another man had the mattress in his forecastle bunk ripped open by a sword driven through the planking. One shudders to think that these rammings might have taken place when the men were sleeping in their bunks.

About seven years ago Captain Nels Amero, of the "Doris Amero," of Gloucester, Mass., harpooned a swordfish in the head. The fish, seemingly crazed by the blow, swam directly at the bow of the boat and drove its sword through a three-inch white oak plank in the hull and a three-inch hard pine board in the inner ceiling of the boat. These planks had to be replaced when the schooner came into port.

In July, 1937, Captain Bert Poirier, also of Gloucester, Mass., had an interesting experience with a swordfish, which he has kindly communicated as follows:

> We left Gloucester, headed for Browns Bank 250 miles away. Upon reaching the swordfish grounds, we harpooned and brought in several fish without incident. Soon after this we sighted a swordfish finning high. At this time six men were aloft on the topmast. The striker was ready with the harpoon, a man stood by with warp and keg. I was at the wheel with my assistant.
>
> The striker ironed the fish back of the fin, and he whirled around awhile and then headed for the boat at top speed of about forty miles per hour, and struck our bow just forward of the chain plates. The sword was driven in nearly up to his eyes. It went through two and a half inches of white oak and three inches of hard pine ceiling, and we had to cut off about one and a half feet of sword inside the ceiling. When we hauled the fish aboard it was dead. The boat had to go on the railway for repairs.

Last of such attacks to be recorded here is in an account communicated by Mr. Hand. This will help make clear some of these seemingly vicious attacks on the bows of sworders. In 1923 or 1924 his schooner "Blue Goose" was rammed in the following interesting fashion:

> We met the swordfish "head and head." I harpooned it from the end of the bowsprit in the conventional manner. Whereupon it jumped ahead, striking the bow of the schooner with sufficient force to put its sword through two inches of hard pine planking, a space of about five inches, and then through three and a half inches of hard pine ceiling, so that the sword projected about eight inches inside the hold. It broke off close to the outside of the hull, causing considerable leaking. I have the piece of plank with the impaled sword in it.

These and other accounts of attacks on other parts of schooners are of not uncommon occurrence. But it must be said that considering the number of sworders on the grounds, and even more the total number of trips made and the number of fish struck each season, the ramming of schooners is of relatively unusual occurrence in comparison with the much larger number of assaults on dories on the fishing grounds.

(To be concluded)

FACTS AND PHILOSOPHERS

By Dr. J. A. GENGERELLI

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IT is not too much to say that for the overwhelming majority of scientists philosophy connotes a sort of intellectual catch-as-catch-can with no holds barred, a domain of pure verbalism where it is possible to assert opposites in the same breath and ask all manner of idiotic questions. This belief is embodied in the well-known witticism which defines philosophy as a blind man looking in a dark cellar for a black hat that isn't there.

Now there is a reason for this; for in the history of philosophy will be found pious mouthings and nonsense sufficient to corroborate this opinion a hundred times over. Indeed, the only acquaintance which the average man of science has had with philosophy is usually a course in its history in the fall of the year when he was a romantic sophomore. He remembers vaguely that it began 'way back with the early Greeks who were eternally wondering about the nature of the universe and of man and of their relation to one another. Then there was something about somebody who said that there was two of everything; one the original and the other the copy. The originals were supposed to be ideas and they were kept all in one place. The copies were the things one sees and bumps into such as teacups and chairs, and these were not real because they were only the images of the real things. After this there is a long stretch for which he remembers nothing very definitely except that by this time in the semester it rained most of the hour and the professor kept mumbling something about nominalism and realism. He may recollect in a vague way that both the professor and the textbook were very secretive on the subject; but there *was* something to the effect that the chair you were sitting on was not real: that the only real was *Chairness.* When the semester came to its weary end, the estimable man who gave the course was telling about a famous philosopher—some Frenchman or German—who contended that when billiard ball A hit billiard ball B, the latter moved, not because it was struck by billiard ball A, but because God, at that precise instant, decided to make B move in that particular direction and at that particular speed. Ball A had nothing to do with the matter. The fact that billiard ball B never moved unless it was struck by another ball or by a cue stick was irrelevant to the argument: this merely proved that God decided to make B move only on such occasions. The last thing our scientist may remember about philosophy is grabbing up his books after finishing the final examination and fleeing from the room with a panicky feeling for his sanity. Needless to say, he never took the second semester.

The cream of the jest, however, lies in the fact that had he persisted in the face of his better judgment and enrolled for the second half of the course, by June the professor would be discussing Hegel, and by this time our embryonic scientist would be a gibbering maniac.

There can be no doubt, it is true, that the reputation which surrounds the subject of philosophy has been fairly earned. But then we must bear in mind that the history of no subject presents a very pretty spectacle. One can very well imagine how an astronomy major would react to a required year course in "The History of Astronomical Concepts from the Early Egyptians to Copernicus," or

the feelings of a physics student toward a semester three-hour course on "The Pythagorean Theory of Tones." And if we were to make a course on "The Leading Concepts in the Chemical Thought of the Middle Ages," a prerequisite to Chemistry 1A, it would not be hard to predict the frame of mind with which students would approach this subject.

There are always great dangers in estimating a subject from its mere chronology, and it has been perhaps the besetting sin of philosophic instruction in the western world that it has been approached from the historical point of view. The young mind is presented with the *fait accompli* of someone's system of ideas without the slightest preliminary rhyme or reason—with such effects as we have tried to describe.

II

It has become a commonplace to say that we live in a scientific world. If you ask what this phrase means, you are likely to get the answer that we live in a world which is dominated by the products of scientific thought. When you inquire as to whether there is something unique about scientific thought which serves to distinguish it from other kinds of thought, the answer usually is not so prompt. Possibly after several false starts, your informant finally decides upon *factuality* as being its single most distinguishing characteristic: enlarging upon this proposition, he points out perhaps that science arose when men set their faces against accepted beliefs, however hallowed, and proceeded to observe the actual facts of the world about them. He may say as follows:

> I can make the matter clear by an example; science differs from philosophy or theology in that science has to do with the careful observing and tabulating of the phenomena which constitute the various effects of the universe about us; whereas the latter two have to do with suppositions and beliefs. To think scientifically means to have a clear, precise and impartial grasp of the facts and to manipulate these facts to serve some purpose. To put it in a word, the essence of scientific thought might be said to be objectivity.

Now if our friend happened to be the same gentleman whose unfortunate experience as a tender sophomore we recited earlier, he might, by this time, be warmed up to the subject, and could very well continue in this wise:

> For instance, there was a philosopher who contended that there was a world of ideas and a world of objects, and that the world of objects was an imperfect copy of the world of ideas. By what right does a man make such a statement? What *evidence* is there for such a belief? This is as good an example as any of the difference between philosophers and scientists: no scientist in his right mind would think of coming to such a conclusion; his conclusions are always based on *facts*, and the facts at our disposal do not justify such a belief.

The matter could hardly be put more bluntly. Let us therefore open our window and look out at the "facts" of the world. We see palm trees lining the avenue. At one side of the road there is a truck piled high with yellow boxes. These are a few of the multiplicity of details which you might cite as objective facts. I am at your side and agree with your description. But it is permissible if I ask a question. I want to know if the truck is there when we are not looking. You have a longstanding acquaintance with my whimsies, and therefore are quick to fall into the spirit of my question. You point out that the question must be answered positively, for if we stationed a person in front of the truck with instructions to stare at it continuously, he would later report that during the period when we were not looking the truck continued to be present. To make your answer even more conclusive, you suggest as an after-thought that an automatically operated motion picture camera could be stationed in front of the truck. Subsequent examination of the developed film would show the same image on each frame. But now I

ask another question: "How do you know the images are on the film when you are not looking?"

This, of course, is the sort of thing which drives the scientist as well as the layman into tantrums of impatience. Unfortunately, impatience does not imply here anything except the fact that you are impatient. Most of us were impatient when we learned that Euclid defined a line as having length but no width. You, as a hard-headed scientist, take nothing for granted: it is therefore necessary for you to decide what is and what is not taken for granted when you have dealings with a fact.

Now you can be as tough-minded as you please about my question: in fact, the more tough-minded you are the better I will like it. But if you are half the scientist you think you are, you will answer it, and you will answer it scientifically, that is to say, you will answer it clearly and unambiguously, and in a manner which is in harmony with the most scrupulous regard for the facts. If you refuse to answer it, it means that there are dark empty spaces in the texture of your thought and knowledge, and one day, sooner or later, you will have to reckon with them. One may consult Einstein and Heisenberg for corroboration on this latter point. Should you, however, follow your better judgment and decide to answer the question clearly and unambiguously, you will be surprised to learn how much of what you regarded as obvious and a matter of elementary fact, is neither obvious nor factual. It is not my purpose now to make any suggestions in regard to the matter; but one thing is certain—the problems which you will face here are not of the sort which can be answered by looking more sharply at a galvanometer scale; or using a microscope of higher resolving power. Not all problems which face the student of nature are brass instrument problems; some are of the sort which misinformed people call intangible or "metaphysical." But intangible, "metaphysical" or what you will, they arise in spite of all you can do. They are inevitably part of your business as a student, and you must make your choice as to whether you will consider them sharply and with full consciousness, or whether you will consider them in a somnolent logical haze. You may rest assured that if you do not do one, you will certainly do the other.

It may be felt, perhaps, that the question of the existence of the truck is too far-fetched. If this is true, it is only because you feel strongly on the subject. Let us attempt a more suitable example of a fact which is not a fact. It is frequently asserted that electrons exist. Perhaps one of the most direct experiments which is said to prove their existence and their idiosyncrasies is the famous Millikan oil-drop experiment. In this experiment a cloud of oil particles is blown into a chamber which is lighted by a slit. If you look through a suitably adjusted microscope you will see bright little points of light floating in space against the background of a coordinate system which enables you to fix the position of any particular one which interests you. At first they fall downwards under the influence of gravity. But if you press a button which turns on an appropriate electrical field, the points of light drift rapidly upward. You can determine how far the one you are observing travels in a given period of time. You test it again and again, writing down in your notebook the distance traversed. Then perhaps you press another button and reverse the field. This time the points of light move furiously downward, since now they are affected by the *sum* of the gravitational and the electrical field. You proceed as before. The experiment goes on for days. When you have finished you will have columns of figures which are

distances and times. After you have made the proper calculations on the basis of these figures, it is evident that there is a minimum value, and that all other values are integral multiples of this minimum value. That is to say, if your minimum value is x, then the other values will be 2x, 3x and so forth. A thrill of excitement goes through you; you have corroborated the "existence" of the electron.

But what *is* the thing whose existence you have corroborated? Certainly the bright points of light were not the electrons. They were only oil drops. You say that you have proved the existence of a minimum *charge* of electricity, a unit charge so small that all other charges are multiples of it. But what manner of thing is this charge: what can you say of it? There is only one thing which you can say which is a matter of scrupulous fact—a charge is whatever it is that is on a particle which makes that particle accelerate in its motion when you turn on an electrical field. This is what people have in mind when they observe that modern science does not know what electricity *is*, but knows what it *does*. This cliché illustrates so clearly the profound misunderstanding which hard-headed people have of the world of facts. The truth is, of course, that modern science not only knows what electricity *does*, but knows what it *is*. It is *that which* has the idiosyncasies described by the differential equations in books entitled "Electricity and Magnetism." For what would we know if we knew the "intrinsic nature" of electricity? Would we like to know whether it is thick, grey, oblong or three-dimensional? Surely thickness is no more real than the fact of increased acceleration under denotable conditions!

In the last few minutes we have been philosophizing. However, if you infer from the preceding that you should not be hard-headed and factual about the universe, your inference is about as wrong as it could possibly be. The intention was, rather, to demonstrate how necessary it is to be factual, rigorous and tough-minded. But the moral of the tale, of course, is that tough-mindedness and faithfulness to the facts leads one to strange places and makes one say things which seem quite the opposite of what one might suppose is good solid sense. In fact, if you do use good solid practical sense, you are likely to end up saying things which will sound "unscientific" and "philosophical."

To infer, on the other hand, that philosophic thought by its very nature has a monopoly on rigor and hard-headedness would be, as we have seen already, equally erroneous. There is, indeed, but one acceptable statement which is to be made in this connection; namely—that all rigorous and hard-headed thought requires rigor and hard-headedness in thinking. The difference between the domain of philosophy and science is of the same sort as the difference between physics and chemistry, or biology and psychology, or geology and botany. The difference exists by virtue of the difference in the questions which are asked. The human mind, when it works effectively, works everywhere in the same way, that is, clearly, sharply, taking as little unconsciously for granted as possible.

The questions which are asked in philosophy have perhaps, as their only claim to uniqueness, their excessive generality. It is obvious even to a tyro that the question: "What makes solid objects move?" is a less general question than the one "Is the world which we know good or bad?" You may, it is true, think the latter a foolish question; but what mass of analysis, labor, definition and redefinition intervenes between the posing of the question and its final evaluation! It may be said that the generality of the questions which arise in philosophy

reaches its acme, perhaps, in the question "What is a permissible question?" If we must have a phrase, it might be said that philosophy is that domain of thought which occupies itself with the most general questions which are raised by the human mind. It is unfortunate, of course, that not all the questions which face the intellect are concrete and particular and at the level of our habitual perceptions, but such is the sad and inevitable fact.

III

In the meantime, the widespread notion that science has to do with the tangible and concrete and therefore the good and useful, whereas philosophy has to do with the intangible, and therefore the bad and impractical, presents itself as an obstacle to the realization of concrete and practical results in science itself. For if philosophy which has to do with the non-concrete is bad and unscientific, then any question which is not concrete, which has to do with things "you can't put your finger on," is not a scientific question, and belongs to philosophy. There has grown up, particularly in America, what might be called the field-trip view of science. You have your knapsack at your side, and as you walk along, you keep a sharp eye out for a good fact which you promptly stuff in your bag. When you get home, you line up your facts on the table, and see if you can make any sense out of them. It is not easy to say what is responsible for this quaint view of the nature of the scientific enterprise. It would probably be safe to assert that it is a hangover from days when science was young, that is to say, when men were not yet on a speaking acquaintance with the world in which they lived. In those days, of course, there was little else they could do except rubber-neck. As a beginning, one must always merely gawk at a thing as objectively and impersonally as possible: beyond a certain point, however, when one has mastered the general outlines, there begin to arise a thousand details, and if we continue to merely record them in our notebooks as objectively and photographically as possible with what we consider to be true scientific fervor, we discover, to our dismay, that we are never done. What is far worse, we find that these "facts," which we treasure so highly because they are so objective and factual, begin to display a curiously perverse property. They very frequently contradict one another. Logs float and stove lids sink; but battleships, which are made entirely of steel, float too.

The contradictions arise, of course, by virtue of the fact that we try to make our eyes do the work of our heads. Perceptions can not take the place of abstract ideas. It is true that abstract ideas which do not refer to perceptions are mischievous; for they are, except in a very restricted logical sense which does not concern us at the moment, neither true nor false; but a great many respectable scientists seem to go on the assumption that abstract ideas as such are to be avoided because as a class they have a philosophical tinge. The complaint is that they do violence to the "facts" and substitute a metaphysical fiction for a concrete reality. Fortunately for science, most workers do not carry this belief with them into their laboratory; for if they did, physics, for instance, would still be where Thomas Aquinas left it.

It is a curious commentary on the structure of the human mind that a man can come away from the development of a differential equation and contend in the next breath that a scientist deals with facts and only with facts. One of the simplest differential equations of physics, that which enunciates that the acceleration of a body is constant in the gravitational field of the earth, when free from other influences, is separated from the simple fact by a long train of remarkably abstract ideas. For, as you are well aware, if you were to test this

in an ordinary room under ordinary conditions it would not be so. If you let the body drop in a tube from which more and more air were removed, you would find the law more and more in accord with the phenomenon. Unfortunately, you can not prepare a tube which is an absolute vacuum; hence you never succeed in perceiving what happens under the conditions which are specified by the law. What you do, however, is to resort to the rationale of *limits* and in that way you employ a logical pole to vault over a factual obstacle.

Perhaps the single most dramatic law of nature, Newton's First Law of Motion, the well-known proposition that a body in motion continues in motion in the same straight line and with the same speed unless influenced by some external factor, represents at the same time the most dramatic flaunting of the facts as they are perceived objectively and photographically. It took genius of abstract thought to conceive this; keen eyes would not have been enough. It is as if Newton took the universe of perception by the scruff of the neck and jerked it around to assume a posture more to his liking. It is doubtful if Plato's realm of pure ideas can be considered such a brazen transcending of the world of pedestrian fact. The chief difference between those two pieces of intellectual effrontery is that if you denied Plato's it might not make a bit of difference in anything except your attitude toward Plato; whereas if you denied Newton's it wouldn't be possible to predict eclipses so nicely.

One could go on, citing example after example in that domain where man's insight into the universe is acknowledged best, namely, physics, and show that it literally bristles with the most fantastically abstract ideas—sheer constructions, about which, furthermore, are organized those routine facts which come to people's minds when the word "physics" is mentioned. These ideas are the frame of the whole structure: were they to be removed, the whole system would come toppling down into a pile of unrelated, contradictory fragments.

We have perhaps written and read so many elementary science text-books for high school and college freshmen that we have come to believe their easy metaphors. You turn to the chapter on dynamics in some text-book on "Beginning Physics," and time and again you read the disarming phrase "A force of K pounds is applied to the point X." As if a force were like a mustard plaster or a poultice! Little wonder students of science come to think that in science you deal only with pure facts which can be seen and felt. The fact is, of course, that a force is nothing in particular. It is a conceptual entity; it is *that which* gives a body of a given mass a certain acceleration. And if you were to ask questions about mass itself, there would be an even prettier story!

Psychology furnishes a clear example of the mischief which may be wrought by the misleading emphasis on what Whitehead has so aptly called "misplaced concreteness." In psychology we have amassed a staggering quantity of data, and it is piling up at an ever increasing rate. Since it is the latest of the sciences to arrive, it was not slow in appropriating the equipment which had been forged by the other disciplines. There are galvanometers, vacuum-tube amplifiers, oscilloscopes, methods of statistical analysis, surgical techniques and many more which are available; and it must be said that, in general, psychologists have learned to use them rather well. The facts which have been accumulated are, on the whole, undoubtedly correct, but they have so little intrinsic relation to one another! If you are giving a course on motivation, for example, there is ample experimental material. You can cite Warden's experimental re-

sults with rats, showing that hunger was more potent than sex in causing a rat to cross an electrified grill; or Hurlock's findings that children who were praised or punished learned better than those who were neither praised nor punished; then there are Elliot's experiments which show that hungry rats were reliably slower in learning the maze when at the end of the run they found only water, than were hungry rats who were given food at the end of the run. There are investigations demonstrating that competition between two persons will increase performance for each to a greater degree than will competition between two groups of which the two persons are respective members. Going to the field of applied psychology, it is possible to indicate experiments where a slight bonus served to increase by 75 per cent. output in employees who had been members of the firm for twenty years. It is possible to cite good experimental evidence of this sort right up to the end of the semester.

But, clearly, all of this is back work. There is no conceptual backbone from which the data may be suspended: hence the whole enterprise lacks drama and significance. If the course is to have any interest or intellectual dignity you must supply this. This means that a set of definitions and concepts must be constructed which the dumb facts as such can never specify. Unfortunately, frames of concepts and definitions are not to be had for the asking. You will have to determine, first, what it is, if anything, which makes motivation a phenomenon distinguishable, let us say, from ordinary habitual action. When this has been accomplished, you are ready to ask the question, under what conditions does the phenomenon of motivation occur? Everything is going smoothly; you have constructed a tentative hypothesis, when you are reminded of a set of phenomena which flatly contradict the careful structure you have erected. It isn't as if you could carry out an experiment which would throw additional light on the subject: the situation is not of that sort. There exist data aplenty, but they do not square up with your concepts. The saddest part of the whole matter is that practically all the other data fit in very nicely. It is obvious that you must change your conceptual structure. Now if you are sufficiently clever or fortunate, it may dawn upon you one day that the question which you are trying to answer may be negotiated if you look upon the phenomena of motivation as a special case of a more general set of phenomena. You then set to work to carefully define this more general set, and draw out the implications which follow from it. If luck is with you, eventually you may even succeed, and at that moment you are vouchsafed one of the great experiences in the domain of the intellect. A segment of the world which before was a slipshod, indifferent jumble of details now snaps into form and order; you have the thrill of perceiving that certain things of common knowledge which you had always supposed had the closest intrinsic relation to one another, are not related at all, whereas others, which on the surface seem worlds apart are exemplifications of the same thing.

But when you have finished and the first flush of excitement has passed, you are likely to look aghast at your own handiwork. How everything is changed! The old familiar black-and-white distinctions have vanished; the easy landmarks, the self-evident suppositions, the comfortable little paths worn smooth with constant retreading, have been obliterated; in short, the whole mass of clichés with their aura of warm commonsensicality is no more. In its place you have a cold, formal structure, which seems totally irrelevant to the original enterprise.

Precisely for this reason, structures of this sort are not exactly in favor in psychology. They are considered in the nature of quasi-philosophical speculations. Only recently psychology succeeded in separating itself from philosophy, and we must justify the divorce! We must collect facts, more of them and more accurate facts; when we have a great many of these, the relations will become evident enough. In consequence, the energies of psychologists are spent in collecting more data and devising clever experiments. Sometimes the experiments are very clever, but then it is never quite clear what the results demonstrate. There are, in other words, too many psychologists who seem to think that we must collect all the "facts" about human nature. This, of course, is impossible. Every new individual will bring to our notice some new quirk of "human nature," and we shall never be finished. To stare at the universe and note down ever so carefully what you see is not the procedure of science; nor is it much better to peform well-controlled experiments at random. What usually happens in such instances is that we control the wrong things.

In psychology, as in physics, we must approach our material equipped with more than sharp eyes and good instruments. We must approach it equipped with abstract ideas, with concepts which are capable of standing our universe of familiar experiences on its head if necessary. We must not, in other words, be afraid to use our imaginations. This fear of the formal, the imaginative and the abstract in science is doubly extraordinary when we consider that we find these tabooed qualities most prevalent in physics, the most impressive and successful of the sciences.

It is instructive to consider the concept of matter in this connection. Every one knows what matter is! It is the stuff the world is made of. It is usually hard, resistant, takes up space, is heavy, sometimes impenetrable, it has shape and size. Indeed, every one knows it so well that it hardly presents a problem. The difficulty lies precisely in this universal familiarity with matter and its attributes. Because of this, many centuries passed before physics came into being: as long as men persisted in looking upon the most outstanding characteristics of matter as being its wetness or dryness, its hardness, its impenetrability, its weight; in short, as long as men thought of matter in terms of its most familiar attributes, there was very little understanding of the material universe. Understanding came only when it occurred to Galileo and Newton to identify matter with the attribute of *mass*.

Now mass, as the physicist understands it, is one of the least obvious of the attributes which a good factual observer would note in matter. Indeed, it is an attribute so undramatic and imponderable that many professors of physics are impelled, in their beginning course, to dress it up under the delusion that by so doing they are "getting it across" to the student. In consequence, they make such statements as "Mass is the amount of matter contained in a thing." What such a professor is "getting across" is not entirely clear; certainly, it is not the concept of mass as it is understood and used in dynamics. Mass is not the amount of matter, for the simple reason that it is impossible to measure the amount of matter except by measuring mass. And when you measure mass, you measure not the *amount of a stuff*, but the amount of a change in the velocity of something. In other words, the mass of an object is measured by the acceleration which a given defined event gives to that object. It will not do to say that the acceleration is *an indication of the mass* of the object; it *is* the mass of the object. To be even more brutal, the mass of an object is a num-

ber, and this number is obtained by measuring accelerations under certain conditions.

You may, if you insist, retain the belief that mass is more than the measured acceleration under the conditions defined; that, in effect, the measured acceleration is a reflection of the mass. But if you do, there is no telling what good it will do you. Indeed, you are merely insisting on the privilege of holding the belief *that there is a something which is described by an acceleration.* This is rather silly, because there is no need for it. All you need to do is to say that there is, *e.g.*, a billiard ball which under defined conditions obtains an acceleration of n units, and that this is what you mean by its mass. To conclude, this number, which is a description of an acceleration, is the single most important attribute of the billiard ball which is known to science.

Could anything be more bizarre, more contemptuous of the data of the senses! Yet, by picking out, indeed, *formulating,* this attribute of matter in this way, it was possible, in a relatively short time, to create the whole majestic structure of classical mechanics. As if by magic the macroscopic aspect of the whole material world becomes unified under a few simple ideas.

Such are the fruits of intellectual audacity and abstraction! We must never forget that sooner or later, in each and every science, the time will come when hypotheses must be framed which fly high over the familiar pedestrian landmarks of everyday experience. We can not forever be discovering a new nerve ganglion or finding a new plant! It is necessary to observe, but it will inevitably happen that we shall discover ambiguities in our observations. It was only the other day that men came around to persuading themselves that two persons could stand on the opposite surfaces of a spherical earth without either one of them falling off or feeling upside down.

In psychology particularly at this time there is a pressing need for hypotheses of this sort to reconcile the contradictions and ambiguities in the multitudinous carefully accumulated facts. There is need for philosophizing of the most rigorous sort; for the posing of general questions: "What can it mean to understand human nature?" "What can it possibly mean to understand anything?" "What are the necessary and sufficient characteristics of an explanation?" These are not idle unscientific speculations. On the contrary, they are of the essence of the scientific method. It is precisely because we are not clear about them that there is not at the present time among psychologists a fundamental agreement as to how to approach this simple question: "Under what conditions will a person obey the command 'Wiggle your finger.'"

IV

It is clear that there is no place where science stops and philosophy begins. If we insist upon creating an artificial dichotomy of this sort, we do ourselves a great deal of mischief: it can only result in bad scientific method and worse theory. If we would gain an insight into the problem of the relationship between science and philosophy, we have but to ask ourselves this question: What does the human mind attempt to do in its efforts to understand the universe? The answer is that it tries to embrace as many experiences as possible under the fewest possible rubrics with the minimum number of contradictions. This is the basic impulse behind the efforts of all thinking men, be they physicists, biologists or metaphysicians. If we do not keep this fact clearly in mind at all times, we are likely to create for ourselves no end of silly problems and misleading convictions.

It is precisely for this reason that the quarrel between experimental scientists

and philosophers is so badly focused. Some laboratory men, for instance, fancy that their quarrel with philosophers lies in the fact that the latter are so theoretical. This is nonsense, and shows among other things that such experimental scientists do not thoroughly understand their own business. There is ample reason for quarreling with some philosophers, but it is not because they are theorists; it is because they are *bad* theorists. We wish to embrace the universe with as few rubrics as possible, it is true; but if a philosopher comes and announces oracularly that "The Universe is One," we can not but be slightly nonplussed, even though we may admire the utter simplicity of his system. We are nonplussed not because he is so abstract and theoretical, but because he did not say Two, or Three. Like all thoughtful men, philosophers have understood only too well the need of the human mind for generality and simplicity, but very few of them have seemed to understand that a rubric, after all, is a man-made thing and that you can make as many of them as you please. Therefore, most philosophers missed the point which came to be realized with increasing clearness by that group of thinkers and workers later known the world over as *scientists*. These men realized that a rubric must command respect; and there is only one way in which you can command a man's respect, namely, by appealing to his senses. In effect, science is that mode of classifying the universe which makes of perception the last court of appeal.

Unless we adopt this point of view, we are cast upon the boundless ocean of sheer logical construction, where we can make as many rubrics and systems as we please. These systems, as systems, are neither true nor false; they are internally consistent, some are simpler, some are more complex, but of them, whatever their nature, only one statement may be made: They are! It has been the mistake of many philosophers to suppose that their systems could be shown to be true, whereas they had the great misfortune of belonging to this class which transcends perceptual corroboration.

This characteristic of many of the classical philosophical systems has earned for them the opprobium of being useless. So far, so good! But the mischief arises when it is supposed that they are useless because they were so theoretical. We now know that they are useless because they were not theoretical enough. These men did not understand what might be called the Theory of Theories. They did not understand that the phrase "To be true in theory, but not in practice" is a literal contradiction in terms. It is in this sense that we are to understand the proposition that there is no place where science stops and philosophy begins. Science must not be looked upon as a sort of rebel step-child of philosophy. If we must have metaphors, we should rather look upon science as philosophy come of age and into the gradual possession of its adult powers.

Indeed, it is hard to understand what people have in mind when they distinguish so emphatically between science and philosophy. It is certain that the science they are thinking of is not science at all but technology. The very great scientists are all great philosophers in the one and only significant sense in which the term may be used, namely, that they tried and succeeded in imposing upon the universe of kaleidoscopic perception, concepts and principles which made it simpler and more orderly. The illustrious names of Galileo, Newton, Darwin and Einstein come immediately to mind.

THE SCIENTIST AND SOCIAL POLICY IN THE DEMOCRATIC STATE

I. SPHERES OF INFLUENCE

By Dr. CHARLES E. KELLOGG

PRINCIPAL SOIL SCIENTIST, U. S. DEPARTMENT OF AGRICULTURE

THE growing tension in the world forces the citizens of democratic states to look to their own social organizations. Despite great material progress, there is unhappiness, distress and uncertainty. Raving demagogues, whispering propagandists, shouting patriots and whimpering sentimentalists nearly threaten to smother the reasoned discussion of earnest citizens.

The ideas expressed here have come out of books, and discussions, and perhaps a few from experience. They do not comprise a complete system (if there is one). The attempt is to discuss, as simply as possible, the more critical relationships of the scientist to the modern democratic state.

The writer feels very strongly that the future of democracy, and all that goes with it, depends upon the strength, vitality and adequacy of this relationship. Although agreement upon ways and means is not asked for, earnest consideration of the principles involved by young scientists is anxiously hoped for, while there is time.

THE FLOOD OF CHANGE

Change is the rule in human affairs—changes in art, in science, in politics, in moral values and in folk ways. And sometimes waves of change pile up on one another, like great tidal waves that threaten all our ideals and traditions. Glancing back into history, we can see these periods and see how complexity overran complexity until old and trusted patterns of social organization broke down before the new were strong enough to serve. Whether we are on the brink of such a period, or well into it, no one can say now. Likely future historians will simplify our period into a few forces and clashes, and show how certain results —results we can not now foresee—were inevitable. But each of us has too many unconscious assumptions of purpose and prejudice for clear conceptions of the things to come. Like the others before us, we must struggle as best we can with what we have. And we have much.

Not only have we much, but a great variety. The changes in time pile over changes in space. The Mississippi Valley, for example, not only was developed later than New England, and hence differently, but the environmental pattern required different arrangements for use. In the peculiar pattern of southwestern deserts, mountains and plateaus, local Indians, early settlement and Spanish colonization all had a part in producing a different cultural area than in the Great Lakes region or in the Coastal Plain of the Southeast. A social idea or a scientific principle may be important in one of these regions and irrelevant in another. The objectives of democracy, and the use of science to help attain these objectives, follow different courses to their goals. Some of the differences in space may be related to time changes; many are not; and no amount of time can bring a continent to cultural uniformity. Attempts to do so by military forces, or other forces, can bring misery to the people and exhaust the resources, but differences will remain. Sectional conflicts are always arising in a dynamic

world, conflicts that can be solved only by that proper balance between national or continental solidarity and local autonomy.

Each day in each place presents a new combination of facts and forces; each idea overlaps with others; each new thing crowds upon other things. Since the world is no vacuum, each new element wedges itself among the old, to squeeze or to be squeezed, to replace or perish. The new may be accepted side by side with the old, still honored with reverence, and the two inconsistent with one another, like the war profiteer who wills his fortune for a peace memorial. Patents are protected by law, and in other laws monopoly is condemned. Often one can't play new games under the old rules. Look at municipal governments in America! The centralization of social services, for example, calls for new concepts of the public trust. The standards of common honesty for the official of a Colonial village, handling a few dollars under the eyes of his neighbors, were ever so much less important than those of the official in a modern city, dealing in millions spent for technical services. The rules guiding the personal relationships of employer and employee in the wagon shop of a previous century have little application in the automobile factory of to-day.

New inventions raise far-reaching questions. New laws are required, or old ones need revision, if the basic social objectives of the society are to be realized. The American Constitution recognizes that the Congress has a function to perform in regulating navigation on the inland waters but obviously had nothing to say about the use of streams for hydroelectric power; not because the framers of the Constitution thought to reserve this responsibility to the states or local governments, but because the question hadn't arisen. Nor did they see fit to prohibit the possession of machine guns by individual citizens. Neither Jefferson nor Franklin nor even Lincoln discussed the problem of trade unions in huge mass-production industries using the assembly-line technique. In one social and legalistic framework new inventions may advance the objectives of a democratic society, in another the same inventions may retard them.

These questions are not only ones of morals and justice but also ones of technology and economics. They are neither one nor the other. They touch our folk ways and our emotions at many points. The very words "democracy" or "totalitarianism" call forth emotional responses in most of us. They are closely related to freedom, security and patriotism. Should America substitute some other political principle for democracy it would be done under a banner of "freedom," "security" and "country."

It is much easier to resolve the questions superficially in our minds with pleasing platitudes, drawn largely from philosophers of previous ages—philosophers who scarcely dreamed of radios, machine guns, synthetic fertilizers, zippers or flying machines, much less of the problems created by their manufacture, the desires of people to have them, and their use in a more densely populated world. Even in doing that, we may confuse their statements of objectives with those of recommended action for their own current period.

The early advocates of democracy lived in non-scientific ages. Science is absolutely essential in the modern world. This doesn't mean that scientists could or should run the world. One aristocracy would be as bad as another. But their skills are essential. Those same skills that play havoc with our old patterns of living may be used to create new dynamic patterns in which all men can live in peace and justice. This means responsibility for the scientist—responsibility to know, to work with others and

to appreciate the relevancy of his skills and principles.

The challenge to scientific men and to all men who use scientific skills is enormous. Like others, they can see these great strains and cracks within the social structure due to changes, unequal changes, in our techniques and ideas. We have often thought of science as something that is changing the world. It has. But it is more important now that we think of science as something to help make the changes evolutionary rather than revolutionary. Heaven knows it is changing—changing unevenly in different places—nothing can stop that, however much we wail or curse. But how can these changes be guided? How can the parts of our culture be fitted and be kept fitted as we move along?

Certainly if we avoid catastrophe scientists must help supply the answer. And do this while there is time.

Privileges and Responsibilities

Much political complexity can be hidden or ignored by the words democracy and totalitarianism; yet the distinction is helpful, providing neither is used in a completely exclusive sense as applied to any particular state. Between black and white there are many grays. Probably the scientist's concepts of these forms of social organization are not fundamentally different from those of other people. Yet the growing significance of scientific principles and skills in modern society has given scientists such an increased responsibility that they need more than ever before to know where they stand. Much has been said about their privileges, but more emphasis needs to be given their responsibilities.

Democracy is assumed to mean, generally, a dynamic form of government in which the individual has an opportunity for self-expression and for the optimum development of his abilities and tastes, consistent with the general welfare, as determined by the majority after open debate. Under such a system the government has the duty of protecting the rights and opportunities of the individual from trespass by foreign groups and from individuals or groups of individuals within the society. All functions of government are directed by persons selected through orderly processes by the citizens from among citizens. Each one has the responsibility of making judgments regarding the purposes and programs of the state. According to his wishes and abilities he can accept further responsibilities in the activities of the state as a citizen advocate for certain public policies, as a worker or official in political parties or other groups, or as an official of the state if chosen by processes provided for by law.

The essential features of the democratic state grow out of its responsibility for the protection of the opportunities of the individual and its responsiveness to change through orderly, evolutionary processes. Few, if any, particular forms, legislative, administrative or judicial, are characteristic of, or necessary for, democracy. In order to remain consistent with its objective, laws, forms and institutions often need to change. For example, in one age greater individual freedom of action for business may lead toward this objective, whereas, in another age, greater regulation of business may be required to reach the same objective. The opponents of democracy may even insist upon the maintenance of outworn forms in the name of service to democracy, but actually to prevent the attainment of its essential objectives.

The essential features of the totalitarian state grow out of the identification of the interests of a minority with the welfare of the state. The minority may sincerely believe that their program is in the interest of the state. A majority of the citizens may or may not approve this

program, either all or part of the time, but they are not required, or even expected, to assume responsibility for judgments, except in fields assigned to them. Their acquiescence is required, with or without agreement. One great advantage of living in the totalitarian state is that the citizen doesn't need to take responsibility. He doesn't need to study and think about what he should do in the public interest or, say, for whom he should vote. Such a luxury can not be tolerated in the democratic state.

The particular form of the state is not of vital importance. There are many ways by which the minority may gain power, even within the framework of a weakening democracy. Oftentimes, they have first gained a plurality during a period of confusion, when other groups have had no appealing programs. Once the minority has entrenched itself, the ideas of others are excluded, first through rigid controls within its own bureaucracy and later throughout the state.

An initial program is announced vaguely in terms of a slogan or set of slogans. The original idea, that grows into the total idea, is also unimportant to the end result, so long as it gains wide acceptance at first. Any single idea, however good, can become a banner of exploitation, when interpreted to exclude other ideas and other moral values. Emphasis is placed less upon the idea than upon its totality. The partial believer is more dangerous, more to be fought down, than the total disbeliever. The end result is a loss of freedom for the majority, suppression of new ideas, wars with other states and revolution within the state.

In both kinds of states, schools, trade and professional organizations, youth groups and all other activities usually emphasize the same general principles, although there are exceptions. In the democratic state, for example, groups may push their own interests so vigorously as to deny, or attempt to deny, freedom of action for others in some fields. It is even not uncommon to find various kinds of groups with rigid bureaucratic systems like those of the totalitarian state. In a healthy democracy such organizations defeat their own purposes in time, however, from want of general support. But bigness in corporations or other rigidly organized groups is usually suspect in democratic states. The leaders of the totalitarian state may grant certain of the privileges and responsibilities of a democratic society to members within the bureaucracy, and even to the social group as a whole in restricted areas, especially as they feel confidence in their positions of power.

The larger the number of persons whose judgments are involved in the formulation of policy, the longer the time required before action can follow. Thus in times of crisis, when action must follow action speedily for success, the ordinary processes of formulating policy through discussion among citizens is suspended in a democratic state. Even the elected representatives may voluntarily delegate many of their normal functions to a small group or to an executive. It is said that the democracy becomes totalitarian for a brief period. This is scarcely correct. There may be dangers. During a crisis there are always dangers, by definition. But what happens in such a circumstance is that the social group recognizes, democratically, a crisis, and for its duration directs the attention of public officials toward those objectives essential to the continuity of the state, rather than toward many objectives and the more gradual perfection and adjustments of matters less immediately pressing for solution.

A willingness on the part of citizens—farmers, scientists, industrial workers or any others—to turn their problems over lightly to a special group or bureaucracy, except in times of crises, rather than take

responsibility for thought and action themselves, is a grave danger signal in a democratic state. The organization of undemocratic pressure groups, unable or unwilling to cooperate with others in the general interest, leads to a type of confusion that paralyzes the democratic processes of government. By devious means the bureaucracies of such groups may perpetuate themselves, even when their membership as a whole is willing to make those compromises which are the very essence of democratic adjustment.

Many have seen these bureaucratic groups lead to the collapse of democratic government. They fear that the suspension of certain democratic procedures during crises may lead to the danger that the bureaucracy to whom power has been intrusted will become the basis for a totalitarian ruling minority if determined and strong, or will be replaced by such a minority if weak and hesitating. The extent of this danger depends less upon the measures taken during the crisis than upon the extent to which the democracy had maintained its essential goals previous to the crisis. Although the delegation of power is a hazard in times of peace, it may be essential in times of crises. If the social group, the state, has failed to provide opportunities for large masses of its citizens and these have no "stake" in the outcome of the crisis, have nothing to lose and little to hope for, the danger is great, quite regardless of specific measures taken when the crisis comes. And one will come under such circumstances, from within if not from without. A democracy can only protect itself during crises by continual adjustment and planning consistent with its goals during periods of comparative calm, while there is time.

The Cults of Science

Through all the praising of science and all the criticism, it is well to remember that scientists are men, not greatly unlike other men. Some are proficient; others are indolent and lazy. Some are earnest and sincere; others are bluffers. Some are narrow and bigoted; others have a broad and tolerant understanding. All profess to be seeking the truth—the truth that sets men free—but instead, a few seek to mystify and to confuse. Essentially the same may be said of any other group. Scientists are due respect and owe responsibilities, like others, according to their abilities and contributions to society.

Perhaps we may say that the chief function of science, in the social world at least, is to make predictions, and make them quantitatively. The eternal question is less "why" than "how much." The "why" of any action, when known, becomes "how," and from these "hows" scientific principles are developed. On the one hand, we may conceive of the scientist who is concerned primarily with the basic principles of science growing out of the relationships of facts to facts. Then there is the applied scientist, or artist-scientist, who is concerned with the application of these principles in the social world, the relationships of facts to men. These are not mutually exclusive by any means, for most fundamental researches are suggested by problems in the applied fields, and many unforeseen applications grew out of fundamental research. Then, too, most scientists are concerned, to some extent at least, with both. But mere measurement, without regard to the relevancy of the facts, is scarcely science, even though scientific equipment and jargon may be employed. Unfortunately, there are some so-called scientists who are concerned, neither with the fundamental laws nor their application. The former requires tasks beyond their strength and the latter is beneath their academic dignity. Perhaps they are the "pure" scientists![1]

[1] The author intends no criticism of that pure science which is fundamental science. He dislikes the expression "pure science" because of what hides under its cloak that is not fundamental science.

There is too much overlapping to classify scientific activities into a neat system. Yet the rough grouping of these activities into geology, physics, botany, chemistry, sociology and so on has some convenience if not taken too seriously, and especially if not allowed to confine the investigator unduly or cause him to oversimplify his problem. Botany, for example, includes some physiology, physiology includes some botany and zoology, and all three are included in biology. Biological chemistry or biochemistry make a bridge to chemistry but include a lot of physical chemistry which is itself a sort of bridge between chemistry and physics requiring a good foundation in mathematics.

Any one of these names refers only roughly to an approximate area within the total, and each overlaps with several others. Some like analytical chemistry or mineralogy, are much more specific than others, like ecology or geography that deal largely with relationships. An extreme specialization in one small area, as some physicists or biologists have done, leads to isolation and to failure because of an inadequate understanding of relationships essential to progress. An extreme spreading of effort, as some sociologists and geographers have done, leads to superficiality and to failure because of an inadequate understanding of fundamental principles and facts.

Perhaps the greatest harm of these systems arises from the unhealthy desire of many specialists to be recognized prominently in the system. For example, with the torrents of words sociologists have written to prove they are scientists—to establish a satisfying nomenclature—much grist might have been ground. But nomenclature alone doesn't get results. There always will be rivalry between the several groups: the specialists will parade their data in terms of an impressive jargon and the generalists will make their sweeping pronouncements with the latest clichés. A number will maintain their balance. It is upon these that responsibility for work and progress and usefulness in a democracy depends.

Scientific activities may be grouped into other kinds of overlapping categories. A grouping into fundamental and applied science has already been mentioned. Of course, these are not mutually exclusive either. Fundamental research in plant physiology, for example, may include a good deal of applied chemistry. Researches directed toward the solution of practical problems in soil management may lead to the discovery or perfection of fundamental principles in soil science.

Then the individual areas of science are sometimes grouped loosely into physical, biological and social sciences, or simply into natural and social sciences. Many areas have been staked out during recent years and given new names, like cultural anthropology and rural sociology. People are still arguing over whether these and even some of the older fields like economics and political science are really sciences. Certainly much that passes under these names isn't scientific, but the argument is unimportant, in the abstract. What really counts is whether, in individual cases, the investigator has used the scientific method and subjected his results to the objective tests of scientific criticism. The confident arrogance of a few self-appointed generalists in the social sciences, who proudly claim attention because they are not biased by deep understanding in any narrower field, should not lead one to condemn all those in the field. It is almost axiomatic that, when a person condemns any field of knowledge, the only thing disclosed is the speaker's ignorance of the field.

Realizing fully the same kind of overlapping, it is also convenient to think of scientific activities under three heads as (1) description and discovery, (2) in-

vention or development of new things or systems and (3) planning or synthesis of scientific facts and principles with human values in the social world.

In our culture, early emphasis was upon scientific activities belonging within the first group, then later, especially during the past hundred years, emphasis was divided between the first two, and only recently are scientific principles and techniques beginning to be used in social planning to an important extent. They will be used. About that there can be no question. The question is rather by whom and with what consideration to other principles. In the successful totalitarian state scientific principles are coordinated quietly with the aims of the minority in power, while in the successful democracy they are coordinated with the values and aspirations of the majority through free discussion and debate.

So far, there has been a serious lag. It is a commonplace to note that scientists in general, and physical scientists in particular, have been more concerned with the minutiae of their principles and their application to individual problems than with the relationship of science to society. Recently there has been a spirit of neo-classicism in each science whose devotees are more concerned with the outlining of "fields" and the definition of concepts than with the content of the concepts. Frequently, of course, some scientists take a long jump over the sinful world of to-day to deal with cosmic relationships, speculative relationships of great breadth. Not many come to grips with the here-now job of the social group and of governments to try, somehow, to keep things going, to harmonize our industry, our agriculture, our exchange systems, our transportation machinery, our communications, our concepts of private property—in short, the whole collection of thoughts and things, work and play, and fads and fancies that make up our civilization.

Perhaps they have done as well as most other groups, say the executives of business, for example; perhaps less well than the artists. Yet one has a right to expect more of scientists: their job is to study relationships and make predictions. Certainly no group has more at stake in democracy, personally, selfishly, than scientists. An authoritarian system of social or institutional organization holding to the *status quo* in any field is bound, sooner or later, to clap the scientist in jail, or worse, if he remains a scientist in fact. Suppression of truth—of new discoveries and new principles—in one field must eventually lead to suppression in all fields, since knowledge is, after all, one whole. Naturally, new ideas in economics or sociology are more immediately suppressed by dictators or other persons of privilege than new ideas in glacial geology or plant physiology. But recent experience has shown that within a short time even the physical scientist finds he must conform to the official "line." All sciences must have an official line in the totalitarian state.

The need for coordination, planning, arriving at proper relative emphasis, or whatever one chooses to call it, has been recognized vaguely. Partly at least, in response to this need many of the new sciences, so-called, have arisen, like rural sociology, business administration, and many more that are to coordinate many specialties. Thousands of speeches are being made about it. No one seems to be strongly against it, in general. Then why don't we have coordination? Partly, perhaps, because coordinators, as over-all putters-together of many principles, are born, not made, certainly not made with a few easy lessons. Even where they do exist, over-all coordinators can only work effectively in totalitarian states or in organizations that have their essential characteristics.

The democratic process of achieving coordination does not depend upon supercoordinators or administrative generalists, but upon many coordinators; that is, each is a coordinator who has something to contribute and takes responsibility for doing so. This principle is as important to the healthy life of a public or private managing bureaucracy as to the democratic state as a whole. The first step in the process is a common understanding of the problem. Within this framework, each may see where his contribution belongs, and through discussion and compromise with others of similar competence, arrive at more general principles. Scientists have been unwilling to assume their share of responsibility, which has become very great, regarding how their data and principles are used, both outside and inside the government. Many have lacked the courage to speak out as their reasoning dictates. They have seen their data twisted and turned to justify all sorts of "programs," "gadgets" and "cures." Many have become disgusted with the popularizers of science, with the generalists whose lack of understanding leaves them "unprejudiced." But by receding into ivory towers of special cults and of academic isolation they leave vacant a gap they should fill, not in the rôle of a new aristocracy, but as an essential part of democratic government in the modern world, and do so while there is time.

(To be concluded)

PARASITISM IN RELATION TO THE LIVESTOCK INDUSTRY OF THE SOUTH

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Introduction

Unlike the virus and bacterial diseases, that break out with almost explosive violence and spread rapidly among flocks and herds, leaving many deaths in their wake, the parasitic diseases of livestock, more particularly those caused by helminths, tend to be chronic, as a rule, and may take a heavy toll from the resources of farmers and stockmen in the form of stunting, unthriftiness and death, before their presence is even suspected. It is not surprising, therefore, that in the past the major emphasis in this nation's struggle against livestock maladies was placed on the diseases of bacterial and virus origin. With victories against some of the most important of these livestock enemies already won, and others definitely in sight, it is to be expected that in the future considerable attention will be focused on the more insidious but less sensational parasitic diseases.

The gradual eradication or control of one infectious livestock disease after another has resulted in a marked improvement of livestock and, undoubtedly, has been one of the most potent factors in the development of the American livestock industry. As this industry has grown in stature, it has assumed an increasing economic importance, with the result that livestock producers are becoming increasingly concerned over all the factors that hamper successful husbandry. That parasitism is a limiting factor in livestock production is recognized wherever domestic animals constitute an economic asset of some impor-

tance. In countries in which stock and poultry raising are major activities, the economic importance of parasitism bears a more or less direct relation to the economic importance of livestock. In short, the more valuable the livestock industry becomes, the greater is the stake which parasitic depredation entails.

Importance of Livestock Industry in the South

In most of the South, including five South Atlantic states, namely, Virginia, North Carolina, South Carolina, Georgia and Florida, and the eight South Central states, namely, Kentucky, Tennessee, Alabama, Mississippi, Arkansas, Louisiana, Oklahoma and Texas, the development of the livestock industry was hampered for a long time by the presence of the cattle fever tick, the vector of tick fever or bovine piroplasmosis. The prevalence in the South of this disease, to which the native cattle were immune because of exposure to infected ticks, precluded to a large extent the introduction of purebred sires and improved and purebred cattle, generally, from tick-free areas, because of the marked susceptibility of these hosts to tick fever. With the gradual release from tick fever quarantine of all the southern states, excepting two counties of Florida and a very narrow strip of Texas, along the Mexican border, the livestock industry of the South, as a whole, and not merely the beef cattle and dairy cattle sections thereof, has been assuming an increasing importance, with the result that, at the present time, livestock looms up as a highly important agricultural asset in this region, as the following considerations will show:

Based on recent statistical information released by the Agricultural Marketing Service of the U. S. Department of Agriculture,[1] there were present in 1940 in the 13 southern states named, 20 per cent. of the nation's 10,602,000 horses and colts; 80 per cent. of the 4,309,000 mules and mule colts; 29 per cent. of the 68,801,000 cattle and calves of all kinds; 24 per cent. of the 54,549,000 sheep and lambs; 26 per cent. of the 60,207,000 hogs and pigs; 29 per cent. of the 429,042,000 chickens; and 26 per cent. of the 8,567,000 turkeys. According to the source of information previously cited, the 1940 aggregate value of this nation's livestock on farms, including poultry but exclusive of goats, was $5,198,989,000, of which $1,360,486,000 was represented by livestock and poultry on farms in the South. In other words, of the total national value of all farm animals and poultry, for the year 1940, 26 per cent. was on farms in the 13 southern states. The monetary value of the available livestock in the South on January 1, 1940, was more than twice that of its entire cotton crop for that year, including lint and seed, and exceeded by about $175,000,000 the aggregate value of all the cotton lint, cotton seed, tobacco, wheat, cane for sugar and seed, cane syrup, potatoes, sweet potatoes, pecans, citrus, apples, pears, peaches, grapes and all truck crops raised in the South during 1940, according to the value of these crops as determined recently by the U. S. Department of Agriculture.[2] Of the remaining principal crops raised in the South, many, including corn, oats, barley, rye and other grazing crops, are raised principally for livestock feeds and are, therefore, definitely tied up with livestock production. Of the $2,055,019,000, representing the cash farm income for the calendar year 1940 in the 13 southern states named, that derived from livestock and livestock products amounted to $741,469,000 (36 per cent.) and exceeded by about $150,000,000 the cash income

[1] "Livestock on Farms," January 1, Release, U. S. Department of Agriculture, February 17, 1941.

[2] "Season Average Prices and Value of Production, Principal Crops 1939 and 1940 by States," U. S. Department of Agriculture, December 18, 1940.

from cotton lint and cotton seed combined, based on data given in a recent release of the Bureau of Agricultural Economics.[3]

It is quite evident, therefore, in the light of the foregoing considerations, that the South is definitely in the livestock business and that a very large portion of its agricultural industry relates directly and indirectly to livestock production.

Factors Favoring Livestock Parasites in the South

Although livestock parasites are not peculiar to the South and, in fact, constitute a problem of national rather than regional importance, the climate and other physical factors of the southern environment are particularly favorable to the propagation of parasites. Among the parasitic species that are most injurious to livestock, many have free-living phases and others require invertebrate, intermediate hosts. The free-living stages of parasitic nematodes, in particular, thrive best in a mild, more or less moist climate, and those parasites requiring intermediate hosts, such as annelids, mollusks and arthropods, have, on the whole, better opportunities for completing their life cycles on a large scale in regions having a short, cold season, than in those having long, rigorous winters. In short, the mild climate, abundance of moisture and long growing season of the South, factors that are favorable to abundant pasture crops for livestock are favorable at the same time to a thriving parasitism. The association of gross parasitism with the tropical and subtropical regions of the world, based largely on the results of surveys to determine the incidence and intensity of human parasitic infections, has a greater basis in truth than in poetry, even when applied to livestock parasites. As will be shown in the discussion that follows, there are, moreover, a number of pathogenic parasites that are either more or less peculiar to livestock in the South or more abundant there than in other sections of the United States. The entire livestock parasite picture, in so far as it can be viewed in the light of the rather meager knowledge that has been accumulated so far, blends a little better with the background of the South than with that of other sections of this country.

[3] "Cash Farm Income and Government Payments in 1940 are Estimated at $9,120,000,000," U. S. Department of Agriculture, February 19, 1941.

Economically Important Parasites of Livestock in the South

Since the species of farm animals are the same the world over, it is not surprising that the parasitic fauna of these hosts is also essentially the same, regardless of where the farm animals are located. However, parasitic species having a more or less sharp geographical distribution are encountered here and there, most cases of this sort involving arthropod, molluscan or other intermediate hosts, present in one region and scarce or absent in another. Examples of localized distribution of parasites are the common liver flukes (*Fasciola hepatica*), which are abundant in ruminants in the Pacific Coast states, Rocky Mountain states, and parts of the South, and which have a spotty and, apparently, sharply limited distribution in ruminants in some of the North Central states, and are scarce or absent in these hosts in other parts of this country. Another parasite, the fringed tapeworm of sheep (*Thysanosoma actinioides*) occurs in the West but, so far as known, not elsewhere in this country. One species of ruminant stomach worm (*Haemonchus similis*) is known only from the South and Manson's eyeworm of chickens (*Oxyspirura mansoni*) is known only from Florida and Louisiana. In other cases the distribution of parasites in livestock in various places is conditioned, to a greater

or lesser extent, by temperature and moisture, this being especially true as regards some of the pathogenic nematodes that require no intermediate hosts but live for a time in the open. Thus, whereas the common stomach worm and intestinal trichostrongyles generally, that parasitize ruminants, occur in nearly all parts of the United States, being more abundant in some places than in others, hookworms and nodular worms of cattle, sheep and goats, are more important in the eastern half of this country than in the western half, the pests in question being especially troublesome in the South. In swine, the common nodular worms (*Oesophagostomum dentatum*) have a wide distribution, whereas three other species of porcine nodular worms (*O. longicaudum, O. brevicaudum* and *O. georgianum*) occur or are abundant only in the South. The swine kidney worm (*Stephanurus dentatus*) is a parasite of great economic importance to the swine industry of the South and of very little or no importance elsewhere in this country. The kidney worm is, in fact, a parasite of swine in tropical and subtropical regions. It is not known from Europe, except southern Spain, but is widely prevalent in swine in warm climates, including our southern states, its distribution along the eastern border seldom extending north of Maryland. The habits, especially the lack of resistance to cold, of the free-living stages of kidney worms, readily explain the distribution of these parasites. The eggs of kidney worms, in common with those of hookworms and nodular worms, to cite only a few examples among the pathogenic strongyles, develop and hatch rapidly in a warm, more or less moist climate; the larvae undergo their transformations quite rapidly under these conditions, attaining the infective stage in a few days. The films of moisture on the grass and other forage provide the essential conditions for the upward migration of the larvae, which migration, in turn, is stimulated by the favorable temperature. The net result is the invasion of forage by the larvae, this placing the latter in a position favorable to their being swallowed by susceptible grazing animals. Barring the special cases noted, and several others not mentioned, the parasites encountered in livestock in the South are found also in most other parts of the United States.

In horses and mules, stomach worms, ascarids, large and small strongyles and pinworms are among the most debilitating of the internal parasites in the South, as they are also in other parts of this country and, for that matter, almost the world over. In addition to the parasites previously named, cattle, sheep and goats in the South are deleteriously affected by stomach worms of all kinds, intestinal trichostrongyles, lungworms and whipworms, these or most of them being also the most injurious internal parasites of ruminants in other parts of this country. Swine, in the South, as elsewhere, harbor pathogenic parasites such as stomach worms, ascarids, thornyheads and other species, the kidney worms and nodular worms previously mentioned being the outstanding species more or less peculiar to the South. Poultry parasites in the South are, in general, of the same species as those encountered elsewhere in this country.

Despite the specific identity of most species of parasites of farm animals in all parts of this country, the southern environment, as previously noted, provides more favorable conditions, during a greater part of the year, than that of other parts of the United States, for the onward march of most of the injurious parasites, more particularly those that have parasitic stages alternating with free-living, immature stages. Excepting only the larvae of large and small strongyles of equines, that have a marked resistance to inhospitable environmental

factors, such as low temperatures and lack of moisture, those of species of strongyles and trichostrongyles that parasitize food animals thrive best where the weather is mild and moisture is abundant. All the available evidence leads, therefore, to the inescapable conclusion that in the South, and especially in the lower tier of southern States, potential, if not actual parasitism can, and in some cases already has, become an economic problem of greater magnitude than elsewhere in the United States.

The Relation of Parasites to the Average Lower Value of Southern Livestock

Based on the statistical information previously given, 20 per cent. of the nation's horses present in the South on January 1, 1940, had a monetary value of only 18 per cent. of the aggregate value of these animals in the entire country. In the case of cattle, the discrepancy between the percentage of animals in the South and their relative monetary value, was even greater, the relation being 29 per cent. in numbers and 20 per cent. in value. The corresponding percentages for sheep were 24 per cent. and 20 per cent.; for swine 26 per cent. and 19 per cent.; for chickens 29 per cent. and 25 per cent.; and for turkeys 26 per cent. and 21 per cent. Only in the case of mules were these percentage relationships reversed, the 80 per cent. of the nation's mules in the South representing 84 per cent. of the aggregate value of all mules in this country. This is not surprising, considering the fact that in the South the mule has not as yet been replaced by mechanical power to the extent in which such replacement has occurred elsewhere in this country. Evidently the South is using mules for power on the farm and is selecting good stock for this purpose.

Among the factors that are responsible for the lower value of the South's meat food animals, including poultry, poor breeding, inadequate feeding, mineral and other deficiencies, and parasites in excess of those harbored by livestock elsewhere in the United States, deserve primary consideration. In the light of available knowledge, it is difficult to determine the relative damaging effect of each of these and, possibly, other factors that operate to lower the value of livestock in the South. The possible interrelation between the factors named has not been even superficially explored, as yet, and no one is in a position at the present time to even venture a definite opinion as to whether such interrelationship really exists. That the excess parasite burden of livestock is partly responsible, in some cases at least, for the lower livestock values in the South is evident from the following considerations:

Early in 1937 the Bureau of Animal Industry investigated the causes of the price differential between hogs sold in southern Georgia and those sold in Chicago and determined that, in addition to the lower value of southern Georgia pigs resulting from a deficiency in yield and softness of the meat of peanut-fed hogs, parasitic infection accounted for part (about 16 per cent.) of the price differential, the estimated loss from such parasitic infection amounting to from 25 cents to 50 cents per hundred pounds of live weight, based on the then current hog prices. During the month of January, 1937, 425 out of 50,000 hogs slaughtered in one plant in southern Georgia were condemned entirely. Of those so condemned, 245 (57.64 per cent.) were considered unfit for human food because of parasitic infection, due largely to kidney worms and associated lesions. In addition, approximately 95 per cent. of the livers and practically all the kidneys of the 50,000 hogs under discussion, were condemned as unfit for food because of infection with kidney worms. An average of one pound or more of perirenal

fat had to be trimmed from each hog because of the presence in this tissue of this parasite. The total loss involved in all these condemnations, including trimming of the loins into which kidney worms had penetrated, amounted to approximately $18,275, this giving a loss per hog of approximately 37 cents.

It is significant that this appreciable loss was due, in the main, to only one out of a dozen or so common parasites of swine. That the loss involved could be appraised financially was due to the fact that the records were made available through the cooperation of the meat packing establishment where the hogs had been slaughtered. The parasite losses of all kinds sustained on the farm as a result of stunting, unthriftiness and deaths, spread out so that they excite no undue alarm, can not be readily measured. That these immeasurable losses are as great as, if not actually greater than, those that have been ascertained in packing plants in special cases, is well known to workers the world over who are familiar with gross parasitism and its effects on meat food and other farm animals.

Host-Parasite Relationship

Some persons, impressed with the relative size of worms and their abundance in animals, ascribe most or all unthriftiness in farm animals to these parasites, whereas others, adopting an equally extreme view, disregard altogether parasitism as a factor in livestock production. Those who subscribe to the former view assume that the failure of domestic animals to grow normally is due almost exclusively to the inroads of parasites, an assumption that is warranted only if other factors, especially breeding, feeding and mineral deficiencies, can be eliminated as possible complications. Gross parasitism produces a symptom-complex resembling that of malnutrition in general, but not all cases of malnutrition are parasitic in origin. The view that parasites have little or nothing to do with unthriftiness is as unsound as the opposite view, and is based, as a rule, on deductions from unsound premises. The failure to find gross or more or less marked parasitic infection in cattle, sheep, swine and poultry that have been slaughtered for food is not good evidence that such infection did not exist in these animals before they reached market size. Like other living things, parasites go through, rather rapidly, periods of youth, maturity, during which they reproduce at almost unbelievable rates, and finally drift into a stage of senescence with its inevitable consequence of death and elimination from the host. Moreover, the evidence that has accumulated during the past few decades shows that immunological phenomena enter into the host-parasite picture, and that, in time, hosts become not only refractory to parasitic infection, but actually lose, in some cases, their parasite load, when the host's resistance gains the ascendency over its susceptibility. In short, while the slaughter house is a happy hunting ground for the parasitologist in need of material for class use or research, it has only limited value in actually affording information on the wide prevalence of parasitism in farm animals. That some information concerning the prevalence of parasites is obtainable in abattoirs, more particularly as regards species that leave an indelible impression on the host in the form of macroscopic lesions, such as those produced by kidney worms in swine, nodular worms in sheep and liver flukes in cattle, is self-evident. However, the essential facts concerning parasitism in livestock can be ascertained best by investigations on the farm, or under farm conditions, designed to disclose the rate of acquisition of parasites and the changing parasitic fauna, especially in young stock, in association with morbidity and mortality.

Methods of Control

The two principal weapons that have been used with success in controlling livestock parasites are chemotherapy and sanitation. The former is designed principally to cope with parasites already well established in their hosts and is largely curative. The latter has as its object the prevention of gross parasitic infection and is, therefore, prophylactic. The prophylactic use of drugs as a means of controlling livestock parasites has given good results in special cases.

In general, the application of existing information to the prevention of parasitic infection has lagged far behind the available knowledge on this subject. Livestock producers appear to be more inclined to spend money for cures than to exert efforts in the direction of dispensing with the need of cures. Evidently, the assumed magic of drugs has a stronger appeal than the prosaic tasks incident to prevention. Treatment of parasitized animals and, in some cases, periodic prophylactic medication have their place in a sound program of livestock sanitation. The use of drugs possessing little or doubtful curative value is all too common, however, to be disregarded, and should be combatted vigorously in the interest of the welfare of livestock producers. It must be remembered that few, if any, diseases of man or livestock have been eradicated or even successfully controlled by chemotherapy. The value of prophylaxis, on the other hand, has been vindicated time after time as the truly magic weapon for coping with many serious diseases of man and farm animals.

Prevention of parasitic infections must be based on sound knowledge of life histories and modes of dissemination of the causative agents. Such knowledge is accumulated slowly by observation and experimentation, the facts ascertained constituting the only firm foundation on which control measures can be successfully planned. The present state of this knowledge is comparable to a structure of which only the masonry has been put up, with work on the interior only just begun. Pasture rotation, rotation of stock, use of temporary pastures whenever possible, sanitation of animal shelters, special care of young stock and similar prophylactic measures represent only the walls of a sanitary structure, the completion of which will require the efforts of many skilled scientific artisans, versed in the technique of research and possessed of a view-point that discovers in the raw data of science practical applications that can be utilized in erecting barriers to impede the unrelenting push of parasitism.

MODERN INSTRUMENTS AND CONTROLS

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I

Industrial instruments and automatic controls present a perplexing picture to many of us. Although we may be cognizant of many startling applications of instruments and controls, we may be unaware of their less impressive, but tremendously more important uses. The "mechanical man" conception of automatism, often popularized at past exhibitions and fairs, is essentially devoid of truth. Presentation of automatons in detail, even as to the shape of man, suggested that instruments and controls simply substitute the hands and brains of man. This conception belittles both man and instruments, as for innumerable applications one is beyond substitution by the other.

Industrial use of instruments and controls is so essential to many applications that a breakdown in the control system results in complete stoppage of the manufacturing process. During the present crisis, instruments and controls are playing a silent, but salient role in keeping our factories, ships and aircraft in constant operation. In modern manufacturing operations, many variables are encountered which must be measured and controlled, such as temperature, pressure, flow and chemical composition. For instance, temperature is only one variable which must be controlled to produce a sheet of paper with consistent quality and properties. In so many industrial applications, the final result does not depend upon control of one variable, but upon control of many.

Instruments and automatic controls have progressed to their present stage of development in three distinct steps. First, it was desired to measure the conditions under which various operations proceeded to a satisfactory conclusion. Indicating thermometers, pressure gauges, speedometers and flow meters were developed to tell just what changes were taking place. Later, it was desired to record the changing conditions. Recording instruments were developed and were found to be of inestimable value in analyzing a process, comparing it from shift to shift and from day to day. Finally, automatic controlling instruments were developed not only to measure the variable quantity and record its magnitude, but actually to maintain the variable within very definite limits by purely automatic means. To-day, all three forms of instruments, indicating, recording and controlling, are playing an indispensable role in our daily life.

II

Instrumentation has developed hand in hand with continuous processing so vital to the petroleum and chemical industries. Development of new instruments has encouraged the use of continuous processing. Conversely, increasing efficiencies possible with continuous processing have resulted in demands on the instrument manufacturers for new control devices.

The petroleum industry is outstanding for its magnanimity of continuous processing operations and for its use of automatic controls. Fifteen years ago, nearly all refinery operations were conducted on the batch basis in which relatively small quantities of substances were refined at one time. Such operations may have required but a few hours, or possibly several days for completion. Regardless of the time involved, upon completion of the refining operation, the final products and by-products were discharged, the equipment involved shut

down, inspected, cleaned and recharged with the process raw materials. In many cases, long periods of waiting were necessary while the apparatus cooled to a tolerable working temperature. The time between discharging and recharging such equipment represented a complete loss. It was necessary to employ several duplicates of such equipment to give a refinery an overall continuous production. Savings of time and labor accomplished by present continuous processing are responsible to a great degree for the reduction in gasoline and oil prices effected during the past decade.

Cracking or thermal decomposition of oil is of major importance to the petroleum industry and to all consumers of petroleum products. By cracking methods, the yield from crude petroleum of fuel for use in internal combustion engines, automotive and aircraft, has been increased by over 30 per cent. Cracking processes now are carried out in units with capacities as great as 30,000 barrels per day, as compared with units of 125 barrel capacities two decades ago. In the pioneering days of cracking, small units were designed and operated in batteries. Frequent shutdowns of individual units were expected and provision was made for such eventualities. Modern refineries carry out their cracking operations with two or three single units having capacities equal to entire batteries of former units. With such large units, shutting down involves great expense and hazards. Use of automatic devices and centralized control has enabled such processes to continue in operation for months at a time in complete absence of shutdown hazards.

III

Instruments make up the nervous system of the modern air transport. Together with radio, instruments have made air transportation an exact science. To-day, the airliner travels over an invisible radio highway; the pilot keeps the plane on its true course without making visual reference to ground objects.

Modern passenger aircraft instruments may be segregated into three general classifications, namely, (1) navigation, (2) engine and (3) radio instruments. The pilot acquires information concerning engine conditions from a set of instruments located on the main instrument panel. In a twin-motor plane, there is a set of instruments for each engine. Radio instruments aboard vary with the extent of radio facilities provided by the airline. Unfortunately, the invisible radio highways made possible by coordination of instruments with radio do not form a complete network over our commercial airways. The trend is to flying along the radio beam and, with developments as planned, our airlines will continually avail themselves of the latest advances in instrument flying. Although there are nearly three dozen instruments on the panel board, it is difficult to distinguish their relative importance; all convey vital information to the pilot.

An artificial horizon indicator enables the pilot to keep the plane perfectly level. An altimeter indicates the height of the plane above sea-level. From his knowledge of the terrain below and a knowledge of the barometric pressure, as received over the plane's radio, the pilot can make adjustments so that when landing the altimeter will indicate the exact altitude of the plane with reference to the landing field below. Two altimeters on the instrument board check against each other and ensure this information in case of one instrument failure. Two instruments provide the air speed, from which the pilot can adjust the plane's speed to conform with predetermined schedules. A rate-of-climb indicator denotes the plane's rate of vertical ascension or descension.

Individual instruments for each engine indicate the engine speeds, fuel, oil and manifold pressures, all important considerations for proper engine opera-

tion. Two instruments indicate the temperature of the hottest cylinder on each engine, a most important consideration, since airplane engines do not operate satisfactorily or economically above a given temperature. A gauge indicates the volume of gasoline fuel in each of four fuel tanks. Still another instrument indicates the temperature of the outside air, important for making proper adjustments pertaining to the performance of the plane. All these instruments are concerned with the manual operation of the plane.

A "gyro" or automatic pilot assists the pilot in performing the routine duties of flying and may be cut in or out instantly at the will of the pilot. While in operation, the gyro pilot actually flies the plane, keeping it perfectly oriented about all three axes. When the gyro pilot is in operation, the pilot performs a left bank turn merely by turning a knob instead of manually adjusting the rudder and ailerons. Whenever cruising conditions are normal, the gyro pilot is used, enabling the pilot to devote more time to other important duties concerned with radio communication and navigation calculations.

Radio not only serves as a means of communication between the plane, airport and weather stations, but also provides an invisible air highway between terminals. A radio beam provides the pathway and instruments aboard indicate the plane's position with reference to this path. United Air Lines Mainliners are equipped with four radio receivers and one transmitter. The four receivers are tuned to four different bands of radio wave frequencies. One receiver indicates the plane's left or right position with reference to the guiding radio beam extending from terminal to terminal. Another receiver automatically turns on a light when the plane has arrived at a given destination, or at the intersection of two radio highways. This receiver also turns on a light when the plane is approaching the airport, lights another when the plane is passing over the edge of the airport and still another when the plane is directly over the airport. A third receiver is sensitive to waves emitted by regular radio transmitting stations. When the pilot tunes his receiver to one of these stations, an instrument automatically indicates the angle which the wave from this station is making with the plane's line of flight. Location of this station is ascertained from the call letters and by tuning the receiver to another station and ascertaining its angle, the pilot can calculate the exact location of the plane. A fourth receiver is used in connection with the plane's transmitter and serves as the line of communication between the plane and airports and weather stations.

As many as seven additional receivers and two additional transmitters are being considered for installation as standard equipment on the Mainliners. A new transmitter and receiver will provide absolute altitude readings above the terrain below. These will not be dependent upon sea-level and barometric pressure readings. The transmitter will emit a radio wave which will be reflected by the earth's surface and received by the plane's radio in an instant. A receiver now being developed will provide the pilot with an invisible glide path for making a complete radio landing. When this device is in use, the pilot will consult the glide path instrument when approaching the airport. The radio glide path instrument will indicate the plane's left-and-right and up-and-down position with reference to the glide path. By keeping the plane adjusted in accordance with this instrument, the pilot will bring it down to the field in a perfect landing without making visual reference to the airport. Such instruments are accurate to within much less than a foot in either direction. Wide use of these instruments is being made in Europe for landing giant bombers during adverse weather conditions.

IV

The steel industry has given increased attention to instrumentation during the past decade and, to-day, instruments and controls are playing a major role in the industry's production of higher quality steels at lower costs. The complete coordination effected by controls and the extreme flexibility of their application has resulted in faster mill operation and greater production. A modern steel mill represents a massive concentration of power. In a rolling mill, the total power of the main rolling drives may be as great as 30,000 horsepower. In many cases, this vast amount of energy is controlled by less than one-half dozen men. To utilize such an enormous amount of power safely and effectively, the operators controlling it must have a great number of facts available instantly at their finger tips. When it is realized that steel slabs and sheets pass along the production lines at speeds as great as 2,300 feet per minute, it need not be stressed that major operating adjustments must be made in advance. Only through instruments can such information be conveyed to the operators. Only through instruments can adjustments be made in time for safe and efficient operation.

Two instruments serve as primary guides in rolling mill operation, namely, a wattmeter which indicates the amount of power being consumed in the rolling stand and a tachometer which indicates the speed of the rolls. These instruments serve to proportion work from one rolling stand to another and to make speed adjustments in advance. Temperature is of primary import to steel production from the time ore is reduced in the blast furnace to the final fabrication into a finished product. With temperatures as high as 3,000 degrees involved, ordinary thermometers are useless. Fortunately, the science of pyrometry has evolved instruments which can measure temperatures of objects without contacting them physically. Recent advances have made it possible to read the temperatures of molten steel in the open hearth furnace, of an ingot in the soaking pit and of a rapidly moving steel strip, as it passes at high speeds through the rolling mill. The temperature of this moving strip not only is indicated, but is recorded on a chart.

A knowledge and control of the temperature of steel as it is produced and processed is of utmost importance to the ultimate consumer. The proper grain structure and surface finish, so important to subsequent fabricating operations, are dependent upon the steel's temperature during the latter stages of the rolling operation. This is only one example of a variable which must be measured and controlled in order that steel will come up to specifications.

V

Air conditioning is a field which has received considerable attention during the past decade. Many of us fail to realize the extent to which successful air conditioning is dependent upon automatic controls. Industrial air conditioning, where exacting temperatures and humidities are maintained in manufacturing and storage buildings, is an integral requirement of many modern industries. Exemplary for their dependence upon humidity control are the tobacco, textile and paper industries. Controlling the percentage of water vapor in the air not only requires removal of moisture, but more often the addition of moisture. Many industrial processes and materials are sensitive to humidity and temperature changes impossible to comprehend without the aid of instruments. For example, a change of only 2 per cent. in relative humidity necessitates the adjustment of a cigar-making machine.

In air-conditioning installations of vast dimensions, large numbers of instruments and controlling devices are

required. Over sixty recording controllers are used to maintain the air temperature to within one half degree of the desired temperature in a large broadcasting company's studios and offices. In this million dollar system, twenty-three million cubic feet of air per hour are moved through the system, providing a change of air every eight minutes. Dependence of successful air conditioning upon accurate regulation of temperature and humidity has been a great incentive to the development of better instruments and controls. Conversely, the availability of fine instruments has fostered the great expansion of the air-conditioning industry.

VI

Modern power plants are responsible in no small degree to instruments and controls for their present admirable status. Production of steam in quantities of 700,000 pounds per hour, not uncommon in our large power plants, represents a vast undertaking and responsibility to the operating staff. As with continuous processing in the petroleum industry, instrumentation has encouraged power plants of increasing magnitude. With pressures as high as 1,400 pounds per square inch and temperatures as high as 800 degrees, the hazards are too great to allow the operating responsibility to rest solely upon a staff of skilled workers. Instruments and controls work all hours of the day and night, constantly checking upon the actions of the operating staff and ruling out mistakes.

One of the most important controls in boiler operation is the automatic feedwater regulator. As water is converted into steam, the water level in the boiler falls. The feedwater regulator automatically functions to supply fresh water as fast as steam is produced. In large boilers supplying as high as 60,000 pounds of steam per hour, it is possible to maintain the water level to within a three and one half variation! Of course, responsibility for such accurate operation is not rested solely upon one instrument or control system. Several instruments stand by and give alarms, if the level falls below that predetermined for safe operation. An instrument which has enforced boiler room economy to a great degree is the carbon dioxide meter. The most economical burning of a fuel is obtained when the gases exhausted from the stack contain a definite percentage of carbon dioxide. Therefore, an instrument which is sensitive to the quantity of carbon dioxide present in the flue gases can convey this information to the operator, or in itself actuate controls which regulate the amount of air being forced into the combustion chamber. Nearly perfect combustion can be maintained by using a carbon dioxide meter for regulation of draft.

Like the production of steam at enormous pressures, the production of chemicals entails many hazards during the process of their preparation. The chemical industry is one of the better customers of the instrument manufacturer. A new two-million dollar synthetic phenol plant is exemplary of what modern instruments and chemical engineering design can accomplish. This plant has a production capacity of 15,000,000 pounds of phenol per year with impurities and by-products less than one tenth pound per pound of phenol, a phenomenal achievement in chemical manufacture. And yet this outstanding plant requires only seven men and one supervisor per shift for complete operation! This is an example where labor has not been replaced because of savings in wages and salaries, but because of the greater accuracy and responsibility obtained with automatic controls.

VII

Very few products reaching our homes have escaped passage through some

process environment controlled automatically. For instance, in a large dairy installation, over 40,000 pounds of milk are pasteurized per hour in an automatically controlled process. Milk is pumped into the pasteurizer between 40 and 50° F., brought to a temperature of 145°, held at that temperature for thirty minutes and then pumped through a cooler to a bottling machine. Automatic devices control the entire process and a recording thermometer charts a continuous record of the process temperature.

The industrial trend is toward coordinated process control, the latest development in control systems. Time is the governing factor in coordinated control. It is not enough to control a temperature within definite limits from hour to hour. Some processes require holding a temperature at 180° for thirty minutes, gradually raising that temperature to 200°, holding it at that point for two hours, and then lowering it to that of the atmosphere. Such a cycle may have to be repeated time after time. Simultaneously, a pressure may be involved which requires controlling in accordance with a fixed program. Master controllers coordinate any number of variables. Flow of fluids, pressures, temperatures, level of liquids, all may be controlled simultaneously by a master program controller. Thus, the variables are controlled in accordance with their variations as a group, as well as their variations as individuals.

Industry is giving increasing attention to telemetering, the science of transmitting information detected at one point to another point a distance away. Ordinarily, indicating and recording thermometers, pressure gauges and flow meters are installed within one hundred feet from the point where the actual measurement is being made. With the aid of telemetering, the variable may be measured and its magnitude recorded many miles away.

Included among the advantages claimed generally for automatic over manual means of control are the production of higher quality merchandise with a reduction of labor and other costs. Many substances are in commercial production to-day only because automatic controls have made the manufacturing process possible. Where production conditions are sustained within definite limits from hour to hour and from day to day, it is evident that the resulting products will be more consistent in quality. Savings of time and labor effected by controls allow more and better materials to become part of the finished product. It can not be denied that automatic control has added to the quality of many of our products. True, instruments and controls have displaced labor from the operation of many processes, but it must be emphasized that controls have made innumerable jobs possible. This is true not only in the manufacture and maintenance of instruments themselves, but in the creation of processes impossible to carry on by manual means of regulation alone.

Time saving accomplished by the use of controls is proved by an example from the tobacco industry. A previous process for humidifying tobacco required the tobacco to remain in a sweat room for a period of two weeks. With a new process, the same amount of moisture is added to the tobacco within a period of nineteen minutes. During that nineteen minute period, the automatic equipment operates forty valves from one to six times each, a task impossible manually from a practical viewpoint.

All of us are surrounded by instruments and controls. Usually their accomplishments are so subtle and reserved in action that we tend to assume their results as a matter of course. Were all industry suddenly to revert to manual means of control, the bottleneck so produced is beyond comprehension.

LANDED ESTATES AND PEASANT FARMERS IN HUNGARY

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THE present war in Europe is being fought on many fronts. Battles are waged on land, on the high seas and in the air. But perhaps for the first time in modern history, the most important engagements take place on fronts less spectacular than those appearing in newsreels and press reports. This new kind of battle is fought in the studies of ministers and diplomats and is fought on a double issue. While it is true that the major preoccupation of the negotiators is to recruit allies, to assure the supply of vital raw materials and to protect the great trade routes, an increasingly important part of these negotiations is devoted to future reorganization of Europe, to the peace that is to follow this conflict. It is in this connection that the present structure of European states is of supreme importance. A new and better organized world can not be built upon a combination of states separated by political, economic and social differences. These differences can and must be solved or any new order will have no better chance to survive than that created by the Paris settlement of 1919.

The social and economic organization of some states in Central and Southeastern Europe has frequently been termed as "feudal." Many writers have described the problem of great masses of landless peasants, exploited by a small class of omnipotent landlords. Few of these studies, however, have attempted to discover the origin of the problem, to analyze its factors or to present a logical solution. Hungary, among these states, has been characterized as the land of giant estates and of very small peasant farms. The purpose of this study is to describe the formation of this social and economic system, to analyze present conditions and to attempt an outline of reforms that might improve the lot of millions of poor peasants.

I

Hungary occupies a central position in the Danube Basin. Many times it has played a decisive part in European history. Many influences have penetrated its land and people, many invasions have menaced its civilization and forced the inhabitants to rebuild time and again.

Medieval Hungarian society was based on the feudal system. The social unit was the village community. Early Hungarian agriculturists have doubtlessly been influenced by the social and economic systems prevalent at this period in neighboring countries. Of these, perhaps the Russian and the South Slav systems were the most important. The Russian "mir" was a village community, with common lands, directed by its elders. The South Slav "zadruga," on the other hand, was a house-community where several hundred people, kinsmen united in families, lived together. They have each exerted considerable influence on early Hungarian life. The pattern of land use in Hungary during the Middle Ages was probably midway between the Eastern and the more advanced Western European systems. The village community paid dues and taxes to the landlord and to the church. It cultivated its fields in the three-year crop-rotation system common to most of the lands west of the Carpathian Mountains.

This system, although allowing a certain freedom to the serfs, burdened them heavily with taxes and forced labor. The idea of peasant revolutions, of the French "Jacqueries" of the fourteenth century, of the Hussite movement in Bohemia and Moravia, during the fifteenth century, found ready followers on the Hungarian plains. The rising tide of small, local rebellions against overtaxation and oppression culminated in the first years of the sixteenth century. In 1514, an army of several hundred thousand Hungarian peasants, recruited for a Holy War against the Turks, refused to disband when the Crusade was postponed. They marched against their lords, massacring, looting, giving free outlet to all their age-old grievances. The peasant revolution was finally crushed after a severe struggle and its leaders executed. The consequences of this rebellion were fatal both to Hungarian peasantry and to the country. The Hungarian Parliament, in 1515, adopted a series of laws, creating more taxes, additional forced labor and binding the serf to the soil where he was born. Ten years later, when the country rose for a final struggle against the Turks, the peasants, a powerful military factor, were virtually prisoners in their fields. In the battle of Mohács, in 1526, Hungary lost its king, its freedom and its unity for 160 years.

The years following the Turkish victory were among the darkest in Hungarian history. The heart of the country was under Turkish rule. Its population deserted the open spaces and formed huge peasant towns, while fields, meadows and gardens were devastated by the invaders. When, at the end of the seventeenth century, Hungary was liberated and the Turks pushed back south of the Danube, ruined homes and deserted fields remained.

In the Austro-Hungarian monarchy of the eighteenth century Habsburg imperialism was opposed by Hungarian tradition of independence. The devastated areas were distributed among the members of a newly created aristocracy, to a great extent of foreign origin. The first three decades of the eighteenth century saw the rise of a series of great landed estates, sometimes covering hundreds of thousands of acres. On these lands, the new lords, under the direction of the Viennese government, proceeded to a resettlement on a great scale. Thousands of farmers from Germany, from Serbia, from Rumania, even from Eastern France and from Italy came to these empty lands, situated mostly in Southern Hungary. They were provided with agricultural equipment, live stock and money, and soon made this region one of the most prosperous areas of the country.

Thus, the Turkish wars, which created a virtual vacuum in the heart of the country, were followed by a resettlement of these areas by foreigners and resulted in a tremendous problem of national minorities. The existence of these national minorities led, finally, to the dismemberment of Hungary after the World War, on the basis of the Wilsonian principle of national self-determination. The creation of great landed estates, after the Turkish wars, led to grave consequences even in areas with a Hungarian majority. When, in 1848, serfdom was abolished, the existence of these estates was the greatest obstacle to the formation of a new, economically sound class of small farmers.

The period following 1848, especially the last third of the nineteenth century, was one of prosperity for Central Europe. Hungary created new industries, developed commerce and built railroads and highways. But the lot of the landless peasant was almost unchanged. In the feudal system, the village community afforded him a certain security, in spite of taxes and forced labor. With the

breakup of feudalism, the peasant was forced to rely upon individual resources which proved insufficient. In the twenty-five years immediately preceding the World War, over 1.5 million peasants left Hungary for the New World. Their place, in many instances, was taken by national minorities. In spite of frequent warnings, that the emigration of Hungarians coincided with the acquisition of Hungarian farms by national minorities, such as Serbians and Rumanians, nothing was done to alleviate the lot of the peasant.

Thus we see how the oppression of the serfs paved the way to foreign conquest, almost unopposed after an initial and fatal blow. The Turkish occupation and the campaigns of 150 years left a land of almost desert character, ready to be resettled by foreign farmers, on giant estates, created to break the resistance of an independent nation. And, finally, the existence of these great estates and the resulting power of landed property led to an unbearable pressure on the peasantry, to mass emigration and to the final dismemberment of the country in 1920.

The years following the World War brought a series of land reforms in most Danubian countries. Little has been done, however, in this direction in Hungary. The Hungarian land reform of 1920 created a number of new farms too small to produce a living to their owners. In spite of a series of bills introduced and passed by the Hungarian Parliament in 1935, 1936 and 1939, the situation is still very grave. Let us consider it in the light of the official statistical data of 1935.

II

As late as 1935, farms of less than 7 acres made up nearly three fourths of the total number of farms. The total area encompassed by them, however, accounted for about a tenth of the total farm area only. Estates of over 140 acres, on the other hand, while accounting for 0.9 per cent. of the total number of farms, occupied nearly one half of the total farm area. The average size of the small peasant farms was but 1.8 acres, while the average of the great estates was 3,320 acres.

THE DISTRIBUTION OF FARMLAND IN HUNGARY IN 1935

Size of holdings in acres	Number of farms	Per cent.	Area of farms in acres	Per cent.
Less than 7	1,142,294	71.5	2,450,000	11.0
7 to 14	200,341	12.5	2,043,000	9.2
14 to 140	240,761	15.1	7,460,000	33.4
140 and over	14,250	0.9	10,035,000	46.4
Total ..	1,597,646	100.0	21,988,000	100.0

Hungary, in the light of these statistics, is a country of extremes. On one side there are a large number of small agricultural units, "dwarf farms," as the Hungarian peasant refers to them. They are too small to support a family, except possibly in the neighborhood of the cities. There, the favorable conditions of a great market, the improved means of communication, the possibility of intensive methods of agriculture, such as truck gardening, orchards, poultry and dairying, might allow an agricultural worker and his family to subsist on a farm of 1.5 to 2 acres, or less.

On the other side, an extremely small group owns over one third of the country. These two categories, the "dwarfs" and the "giants," together make up more than half of the total agricultural area. The above figures, however, as far as the size of the farms is concerned, differ so radically from American conditions that it is desirable to state briefly the bases adopted for this classification.

A controversy of long standing has raged between conservative and progressive agrarian groups in Central Europe over the economic possibilities of small farms. There seems to be a general agreement, however, that farms under

the size of 7 acres can not support an average peasant family. This is possible only if one or several members of the family engage in some other occupation, mostly as agricultural workers on other farms.

The lot of the peasant is somewhat mitigated by the fact that, as a survival of the feudal system, many villages still possess common lands, used mainly for pastures and as forests. In any treatment of the Hungarian land problem these lands should be considered as really part of the small peasant farms. They represent 5.7 per cent. of the total agricultural area.

Between the "dwarf" and the "giant" landowners, there is a rather small group of more fortunate peasant farmers. Their farms range from 14 to 140 acres. This group accounts for about 14 per cent. of all farms, and 28 per cent. of the total farm area.

As to the great estates, they are not always owned by one individual. As a further obstacle to a redistribution of the land, more than one half of the great estates can not be sold except under certain conditions specified by law. Best known among these are the entails or "fideicommis."

The institution of entails subsists only in Hungary and Germany in its true form. It is a safeguard of the great estates. They can not be divided or sold and are handled by the senior member of the family. Although somewhat diminished in importance after the World War, they still are of a great importance in Hungary.

Another category of great estates, those owned by the church, are subject to the same restrictions of sale as the entails. Concentrated mostly in the hands of the Roman Catholic Church, they occupy a surface almost equal to that of the small peasant farms (11 per cent.).

Finally, a considerable area is owned by commercial enterprises, devoted to agricultural production of industrial raw materials, and by endowments, supporting religious and educational institutions.

III

The great landed estates are perhaps the most important problem Hungary faces to-day. In the past they were responsible to a large extent for the impoverishment of the peasants, forced many thousands into emigration and facilitated the formation of national minorities. To-day, their effect is that of conservatism, of obstructing by various means the creation of a sound economic basis for the nation by a more equal distribution of the land. To be sure, some of the great estates have, by the creation of model agricultural units, by the help they give to peasant cooperatives and in other ways, attempted to lessen the burden of the peasant. Still, the existence of the great estates is the major barrier to a better rural economy.

It should also be said that the existence of the great estates perpetuates the maladjustment of population distribution. The great estates have a population density of 10–15 people to the square mile, where areas immediately contiguous approximate or exceed 35–50 people to the square mile. The basis for this inequality is to be found in the agricultural methods as practised by the great estates. Their large-scale exploitation is considerably mechanized, using few farmhands, with the exception of harvest-time when workers from outside are hired. Thus many agricultural workers live in overcrowded villages surrounding the great estates, sometimes under poor living conditions. The statistics of population density and the distribution of great estates indicate a reverse proportion. The greater the area occupied by the great estates, the poorer the opportunities offered to commerce and industry, the lower the general living standard.

The land reforms in the Balkan countries, after the World War, were not prepared scientifically, and they did not provide sufficient capital for the new small farmers. A general decrease of agricultural production, for a period extending from five to ten years, was the result. This has been used as an argument against the creation of small farms. This argument states that the creation of small farms, worked by peasants, with their primitive techniques, would result in a sudden decrease of the agricultural production.

This is contradicted by an investigation conducted in 1935–1936 by the Hungarian Agricultural Union, representing the interests of the great landowners. It appears that the total revenue per land unit (1 Joch = 1.4 acres) is from 14 to 30 per cent. greater on small farms than on the great estates. It has been stated that the total number of cattle, for example, is 17.6 per cent. greater per land unit on the small farms than on the great ones. Finally, this investigation established the fact that the bulk of agricultural products sold either on Hungarian or foreign markets, and representing 70 to 75 per cent. of the country's total production, comes from small farms. However, the yield of the main cereal crops is 18 to 22 per cent. lower per land unit in the small farm. This is a result of primitive techniques and lack of agricultural machinery.

On the basis of these figures, it can be said that the small farms succeed better in the branches of agriculture that require intensive labor, such as dairying, cattle raising or truck gardening. Results are poorer when intensive use of capital, combined with high agricultural skill, is required.

IV

The solution that is first suggested is the creation of tenant farms on the great estates. To-day, the only important region in this respect is the neighborhood of the great peasant towns of the Hungarian Plains. There, small tenant farmers make a very prosperous living on truck crops, wine, fruits, tobacco and poultry.

The creation of the small tenant-farms has already been attempted in one notable instance. On an estate of 13,500 acres, owned by the Roman Catholic Educational Endowment in Eastern Hungary, 9,100 acres are cultivated by 756 tenant farmers, united in a cooperative. They cultivate four acres on the average, their fields being divided in four groups, on the basis of a four-year crop-rotation system. Their products are marketed by the cooperative, their purchases of industrial articles, of fertilizers, are made by the cooperative. This double function of collective marketing and collective purchasing enables the farmer to realize a substantially higher income. An investigation has stated that in the case of individual buying and selling, the farmer was 25 to 28 per cent. worse off than using the cooperative's services.

An additional reform might be a better agricultural education for the farmer. Agricultural education is a rather neglected branch of the general educational system in Hungary. Although during the past years some steps have been taken in this direction, by offering technical agricultural education in rural primary schools, still much remains to be done. It is necessary to open a large number of winter agricultural courses and winter agricultural schools. Winter term should be instituted in the three agricultural colleges, so far mostly specialized in the training of men for the great estates. The small farmer has to be taught the use of modern agricultural techniques. Mastering these, he will be able to obtain higher yields, to raise better cattle, to produce better fruits and vegetables.

As to reforms involving considerable

capital expense, in a country with small capital resources of its own, this is above all a matter of time. Among these reforms the building of new rural roads will aid in the transportation of agricultural products to the markets and will establish new cultural contacts between town and country. Irrigation is still another important reform in this category. The building of irrigation systems and the construction of new roads has already begun on a small scale. It is the amount of capital at the country's disposal that determines the pace of work.

Another important point is a general reform of land use methods. In many villages, small farms have been divided, mostly by inheritance, into even tinier strips of land. These strips, sometimes only a few yards wide, are often at great distances from each other. The farmer has to transport his plough, his fertilizers, his seed and himself from one end of the village fields to the other. The amount of labor wasted through this procedure is considerable. Some experts estimate it to be 25 to 30 per cent. of the total potential labor of the year. The process of unification of these tiny strips, however, is a complicated one. Each little bit of land has to be carefully evaluated, and the little strips exchanged between the farmers. This calls for arbitration and often results in long legal suits. In spite of these difficulties and of the considerable cost involved, this process is an indispensable feature of any land reform.

These suggestions are perhaps the most urgent among the many reforms necessary to a better rural economy. They may act in multiplying the amount of land that actually exists, by increasing the production and offering new opportunities to the peasant.

Peasants all over the world, whether in Hungary, in Kansas or in China, consider land the most priceless treasure there is. Some years ago, a school teacher in a small Hungarian village gave a written test to his pupils. The question he asked was: "If you had 1,000 Pengös (the equivalent of about $180), what would you do first?" And, with a striking unanimity, the little boys and little girls in that forlorn school of the plains answered: "We would buy land, cows, chickens, a pig, and be farmers on our own." Land is a magic word for them. It means better houses, better food, better clothing, it means happiness and prosperity, it means security, it means everything.

A war is being fought in Europe. Nobody knows what the outcome will be. But many people agree that it will bring poverty, famine, misery to many countries. It is a duty of every state, towards its citizens and towards the world, to create better living conditions in its territories. The pursuit of happiness, the major aim of our civilization, although temporarily overshadowed, must be the major goal of every government. And it can not be indifferent to Europe whether countries intend to preserve their antiquated social and economic structure, or whether they are willing to offer new opportunities to their citizens. By doing the latter, they would raise their living standards and make happier members of a new order that will arise out of the ruin and destruction of the present conflict.

ANT BEHAVIOR IN THE FACE OF OBSTACLES

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OCCASIONALLY in the state of nature ants must overcome obstacles placed between them and some object which they desire, such as their nest, food, water or young. More frequently, man himself places obstacles intended to keep ants from approaching his food, trees or gardens; or in the case of myrmecologists, to keep ants in artificial nests from leaving those nests. These situations occasionally call forth unusual responses on the part of the ants, and it is with these atypical responses that this paper is concerned.

One obstacle to ants is water and one variety of artificial formicary uses a metal trough filled with water to keep ants within fixed boundaries. Miss Fielde[1] noticed, however, on one occasion, that some *Stenama fulvum,* which had never previously had recourse to such a method, escaped by swimming. In the case of water used to keep ants from food, Sykes reports a similar case of swimming.

Of course, where water barriers occur in nature, it is usually possible for the ants to tunnel under the barrier, and this method is also reported occasionally to overcome other obstacles. A case of tunnelling under a log placed to obstruct an ants' pathway is reported by Ellendorf. McCook gives an illustration where ants tunnelled underneath an irrigation ditch, and Lincecum a case of tunnelling under a creek. This reminds one, of course, of the much-quoted observation of Clark that ants had tunnelled under the Parahyba River "where it was as wide as the Thames at London Bridge." One of the most interesting observations along these lines is that of Belt,[2] who writes:

> A nest was made near one of our tramways, and to get to the trees the ants had to cross the rails, over which the wagons were continually passing and repassing. Every time they came along a number of ants were crushed to death. They persevered in crossing for a while, but at last set to work and tunnelled underneath each rail. One day, when the wagons were not running, I stopped up the tunnels with stones; but although great numbers carrying leaves were thus cut off from the nest, they would not cross the rails, but set to work making fresh tunnels underneath them. Apparently an order had gone forth, or a general understanding been come to, that the rails were not to be crossed.

Where an arduous pathway is provided by the food placed above the ground and the nest in earth, ants have been known to cut out the long or difficult labor of climbing by having some of their number remain with the food and throw it down to the ground where others removed the food to the nest. There is an ancient observation by Aelian to this effect and modern ones by many observers.[3]

In discussing Jourdain, Cornetz suggests that ants may accidentally drop seeds with no intention of performing a labor-saving act, and adduces several observations to support this point. He considers the crucial point to be whether the ants continue to climb up and down while the seed was dropping. When this point was put to M. Charles Jourdain,

[1] A list of sources for all references has been prepared, and may be consulted at the Library of Congress and certain other important public and college libraries. If these are not convenient, the author will be glad to give information concerning any reference.

[2] Thomas Belt, "Naturalist in Nicaragua," pp. 83–84.

[3] Bates, Belt, Besson, Combes, Gredler, Jourdain, Lund, McCook, Merian, Moggridge and Wasmann.

he replied that although he could not say that no ants continued to climb up and down, their numbers were certainly much reduced if not entirely eliminated. In general, most of the observations here recorded are expressed in such a way as to negative Cornetz' suggestion, while several are by observers of such standing that we may be sure that they would not write as they did unless the possibility of accident was, in their opinion, altogether out of the question. Miss Combes's experiments were directed to this question, and showed that the dropping was deliberate. On the other hand, some observations do not exclude this possibility, Lund in particular remarking that the ants often fell with the leaves they cut. Such behavior could still be intentional, amounting to saving the labor of descending but not of climbing; but the case is not clear.

A rather similar procedure consists in the ants' allowing themselves to fall from a height onto the goal which they seek to reach. Frequently when ants have been cut off by some device of water, glue or turpentine from food, they have climbed to the ceiling or overhanging nearby object and allowed themselves to drop thence onto the food. In some of these observations the ants then obtained their food and dropped with it to the ground. Observations of this type have often been reported.[4] Lubbock[5] wrote:

> At a distance of ten inches from the door of a nest of *Lasius niger*, I fixed an upright wand, and from the top of it I suspended a second, shorter wand. To the lower end of this wand, which hung right over the entrance to the nest, I fastened a cell in which I put a number of larvae, and to them I put several ants. Though the drop was only a half an inch, the ants preferred the long route over the wands. They showed anxiety to go up directly. The ants would not jump down, although the distance was decreased until the ants could touch the cell, and although the length of the wands was increased. Although sifted mould was placed underneath, the ants did not think of piling it till they could reach the larvae directly. An ant would remain a prisoner rather than drop a short distance. If a chasm was interposed between the ants and the desired larvae, they would not think of pushing a piece of paper or a straw across, although the straw was placed almost across already.

Turner on the contrary found that ants could learn to jump down, although he found that they showed reluctance in doing so. Miss Combes found in a number of experiments that the ants jumped down with practically no reluctance. She reports that there was considerable difference in the number of ants jumping when she used rods of different materials or in different positions. The ants apparently preferred to jump from smooth or horizontal rods, rather than from rough, vertical ones. When, in her second series, she repeated Lubbock's experiments exactly, she found that the ants always jumped. Miss Combes' experiments were performed with many nests but not with the same species as those used by Lubbock, which may account in part for the difference in results. Turner worked with several species. With *Camponotus pennsylvanicus*, I have several times observed a well-defined jumping that carries the ant forward as well as down.

A frequent method of protecting trees or other vertical objects is to band them with glue, or sometimes with a cloth soaked in poison. In such cases ants have been known to bring bits of earth and build a road across the dangerous point.[6] The observations of Barber and Theuerkauf are particularly interesting. Barber, of the United States Department of Agriculture, reports that in general

[4] Buckley, Dupont, Leuckart, Oestlund, Sykes, Titus, Vogt, who reports two cases, and Weir; and these observations have been confirmed by the experiments of Combes, Titus and Turner.

[5] Sir John Lubbock, Lord Avebury, "Ants, Bees and Wasps," pp. 240–248.

[6] Examples of this kind have been given by Barber, Besson, Fleury, Jourdain, Leuckart and Theuerkauf.

the banding of trees against ants is effective only a few days, as "the ants would carry particles of dirt and build a bridge over it." And Theuerkauf found that ants that were in a tree at the time when it was banded used aphids instead of dirt to build a pathway over the sticky substance. In some cases vessels filled with water have been filled up with dirt in similar fashion.

The commonest method used in the tropics to protect food from ants is to place the food on a stand whose legs are immersed in basins of water. In such circumstances and in other cases where water has formed a barrier to the ants, they have been known to build bridges of floating particles by means of which they gained access to the protected region.[7] Concerning observations of the last two types Wheeler[8] writes:

> Several writers have described ants as building earthen bridges over sticky bands that at first prevented them from climbing trees, over water moats surrounding their nests, or over the surface of honey placed in their nests. In each of these cases the observer, a trained zoologist, regarded the act as due to reasoning, or at least, as the result of a "practical judgment." In reality, however, nothing more than a reflex or simple instinct was manifested in any of these cases. If the observers had had a more intimate acquaintance with ants, they would have known that these insects almost invariably throw earth, empty cocoons, or particles of débris on any liquid or viscid substance in their immediate environment. Such actions result in covering the whole surface of a small amount of liquid, so that the ants are able to cross over to the other side on what was never intended to be a bridge.

Wheeler's argument seems to me, however, not entirely to the point. That ants will cover sticky substances in their nests where such substances would be dangerous to themselves and their young is undoubtedly true. Such behavior is so regular that it might be called typical. But covering glue on vertical surfaces far from the nest is another matter altogether. It can hardly be thought that ants have the urge to cover all stickiness within a range of fifty yards of the nest: that they do not do so is a matter of everyday observation. Furthermore, it may be noted that Wheeler's explanation would not cover the fact that glue is not invariably coated with earth, and that where this is done it usually is done only over a narrow band sufficient to give easy access to whatever place the ants are seeking to go. In addition, Wheeler's explanation would fail to account for the apparently intelligent choice of floating materials often used in building bridges over water, and the behavior of ants who have been observed in the course of constructing these bridges.

Along these lines the most interesting observation is that of Turner:[9]

> On the same Lubbock island I had a large colony of *Formica fusca* var *subsericea* Say. The island was kept littered with detritus of various kinds. One day I noticed a worker of this colony begin the construction of a bridge across the ditch of water that surrounded the island on which the colony was located. This partial bridge was constructed in the following manner. The ant placed a piece of charred paper about one centimeter wide upon the water on the inner side of the ditch. After walking out on this bit of paper and reaching outward with its antennae, the ant returned to the island and picked up a crumb of bread crust three millimeters wide. The ant then walked across the charred paper and placed this bit of bread upon the water just beyond and adjacent to the paper. After standing for a short time upon the outer edge of the crumb and reaching outward with its antennae, the ant returned to the island and picked up a piece of wood two millimeters wide by three millimeters long. This the ant placed upon the water just beyond and adjacent to the crumb. Thus there was constructed, extending three-fourths of the distance across the ditch, a bridge of three elements. Upon this partial bridge the ant stood for fully two minutes, reaching continually outward with its antennae. The bridge was never completed.

[7] Examples of this type have been given by Ellendorf, Fleury, Jourdain, Kühn, Turner and an anonymous writer in *La Nature*.

[8] W. M. Wheeler, "Ants," p. 540.

[9] *Biological Bulletin*, Vol. 13, pp. 334–335.

Such evidence and such considerations as these force us to reject Wheeler's extreme position in favor of that of Cornetz, who not only pointed out, in connection with the observations of Jourdain, that the covering of irritating substances was typical, but showed by a series of experiments that such behavior could be induced outside the nest. However, he believes that ants show more than instinctive behavior in the choice of materials for building a floating bridge, and shows no disposition to insist that behavior of the type in question is always or necessarily a matter of reflex.

Some older observers, especially Merian, have reported that ants formed bridges built of their own bodies to gain access to various objects or to cross streams. This observation was characterized by Wheeler as a myth, but it has nevertheless been confirmed, at least in part, by several modern biologists of high reputation, including Beebe and Belt, who report this fact of the same genus of ants with which Merian was concerned. Similar observations on other species have been recorded by Dupont, Sykes and Vogt.

A most interesting case is reported by "E. D.,"[10] who explains that he protected a meat safe in the ordinary manner by placing its four legs in tin vessels containing water. One day he found that some red ants were proceeding to the meat safe and discovered that they had built a bridge.

> It consisted of a broken bit of straw, which rested with one end on a mud buttress fixed to the wall, and the other on the overhanging or projecting top of the safe, which came within an inch and a half of the wall. So they must have carried the straw up from the floor, and resting their end on the support they had prepared, let it fall until its other end reached the safe, and then crossed and completed the structure, for it was fastened at both ends with the mortar composed of their saliva and fine earth. Ruthlessly I destroyed the bridge, and moving the safe farther from the wall, managed to prevent their inroads for that season at least. Since then I have frequently seen short bridges, composed entirely of the concrete or mortar which the white ants use to cover up their workings, extending from a damp earthen wall to anything not more than three-quarters of an inch from it.

A unique method of overcoming obstacles was reported to me by Professor A. H. Phillips, of Princeton. He says:

> I had some organic materials out in the sun to dry, and preserved them from attacks by ants by putting the table legs in dishes of water. But one day I found that the ants were carrying away my materials. Anxious to trace them, I watched, and found that the ants, laden with food, were waiting at one side of the table. As a leaf of a nearby cocoanut palm swayed in the wind, it touched the table at this point. The laden ants quickly caught hold of the leaf, while others, unburdened, got off. It was just like human beings waiting for a train.

Several observations of the same type are recorded by Woglum.

Without special consideration, the various methods reliably reported to have been used by ants to overcome obstacles would make it seem that their intelligence is remarkably high and that no ordinary method of preserving food is apt to be successful against them. This, of course, is not a correct analysis of the situation. The essential fact is that placing the legs of an article of furniture in water normally does protect articles on that table from attacks by ants, and the banding of trees is frequently if not regularly effective in similar fashion. The forty-odd examples mentioned in this article are, of course, atypical. If they were not, they would not have entered into the literature of myrmecology in the way that they have. So it is not to be expected that every experiment with ants will show them to possess the ingenuity, or whatever quality may be exemplified, which was shown in the cases considered here. It must not be thought that favorable results would be obtained with any degree of

[10] *Leisure Hour*, Vol. 29, pp. 718–719.

frequency, and there is therefore nothing at all surprising in the negative results obtained by Lubbock. In cases of this sort, where we are dealing with atypical behavior which may be rather rare in nature, the single positive result is of more importance than any number of negative ones.

There are two considerations which make it extremely unlikely that the happenings reported in this article should be interpreted as accidental or instinctive. The first is that in every case mentioned, with one possible exception, the ants had access to their goal before a barrier was interposed between them. Thus it is under conditions most likely to induce purposive efforts to achieve a goal that the successes actually reported have been achieved. This would seem further to discount Wheeler's position, since banding on trees not previously used by the ants has never been reported covered by them.

The second point of importance is that in most cases a considerable delay ensued after the obstacle was put into position before the ants overcame it. Placing a band of glue around the trunk of a tree did not ordinarily cause the ants to respond by covering it with dirt immediately, but instead a period of hours or days elapsed in which nothing whatsoever was done, and then the ants proceeded to cover the band with their accustomed ardor. These considerations seem to discredit any interpretation based on instinct, chain reflex or other similar concept.

Most myrmecological psychologists—and the present writer is in wholehearted agreement—believe that there is considerable variation in the intelligence of ants, not merely from species to species but from nest to nest within the same species, and from individual to individual within the same nest. This has been objectively demonstrated by the maze-running tests of Schnierla. And if this is so we can understand immediately how Lubbock's observation of his nest of Lasius produced consistently negative results, while the present author's experiments on his nest of Formica produced regularly favorable results; how on the question of jumping Lubbock, Turner and Combes reach divergent conclusions; and even how two such great myrmecologists as Lubbock and Forel could get different results from similar experiments on recognition, and each confirm their own results by repeated checks. If such individual variations exist, we might expect that ants who successfully overcame one obstacle would be apt to succeed in overcoming further ones. And this we find to be true in no less than five of the observations considered in this article. Thus Besson, Leuckart and Vogt observe the same ants to use two methods of overcoming obstacles, while Jourdain and Sykes similarly found three. This result is not unexpected. It is natural if success in overcoming obstacles is due to greater sagacity, to greater quickness in perceiving the applicability of accidental responses, to greater perseverance or even to the encouragement which the successful solution of the first problem might give to the ants when presented with a second difficulty.

BOOKS ON SCIENCE FOR THE LAYMAN

THEORIES AND PRACTICES OF A RENAISSANCE DOCTOR[1]

ONE of the strikingly forceful personalities in the history of medicine, and indeed in the history of human thought, rejoiced in the name of Philip Theophrastus Bombast von Hohenheim; he is better known to us, as he was to his contemporaries, as Paracelsus. He was born in 1493 in Switzerland, studied medicine in Italy, traveled over the whole of Europe, from the British Isles to Poland, Turkey and Greece, and died in 1541 in Salzburg, misunderstood, poor, disappointed and prematurely old. Yet so significant a figure is he that last year, in observance of the 400th anniversary of his death, the American Association of the History of Medicine held a Symposium on Paracelsus. In further observance, the present volume of translations has been prepared.

Paracelsus was in many ways the Luther of medicine. In his day the dogmas of Galen were blindly followed, and original observation or deviation from the prevailing beliefs as to the causation or treatment of disease called for condign punishment. Indeed, many of Paracelsus' travels were due directly to the wrath of organized medicine. As for what we now know as mental disorders, the field was largely preempted by the clergy, with their beliefs in demoniac possession and witchcraft.

Many of Paracelsus' writings were not published until after his death (in many cases earlier printing was prevented by his enemies, the professors of medicine); by then his orginality and his contributions to medical learning had begun to be appreciated. The first of the present treatises, known as the Seven Defensiones, did not appear until the author had been in his grave 23 years! He freely pleads guilty to lack of respect for medical tradition unless it has more than mere age to recommend it. He searches for further knowledge, and seeks to be a true Christian in ministering to the sick. Yes, he has used new remedies; all effective remedies are poisonous in excess, but he knows the proper dosage of what he uses; more than can be said of his traducers! Yes, he has traveled widely; how better increase one's knowledge? "Medicine is an art which should be employed with much conscientiousness and much experience, also with much fear of God; for who fears not God, blunders and steals for ever and ever; who has no conscience, has no shame in him either."

The second treatise, "On the Miners' Sickness," has the distinction of being the first monograph on occupational diseases. As Paracelsus points out, we are likely to continue to have hazardous occupations with their attendant disorders; "Besides, we must also have gold and silver, also other metals, iron, tin, copper, lead and mercury. If we wish to have these, we must risk with body and life in a struggle with many enemies that oppose us. . . . And in the same manner as the devil is driven out of man, the poisonous diseases are expelled by means of such physic, just as evil expels evil and good retains good."

Treatise Three is entitled "The Diseases that Deprive Man of his Reason, such as St. Vitus' Dance, Falling Sickness, Melancholy, and Insanity, and their Correct Treatment." Although he subscribes to the doctrines of the influence of the moon and obsessions of the devil, he gives us some startlingly accurate observations on epilepsy, mania and hysteria (which he terms chorea lasciva). He even recommends an early form of "shock treatment"—"The best cure, and one which rarely fails, is to throw such persons into cold water."

The fourth Treatise is "A Book on

[1] *Four Treatises of Paracelsus.* Edited by Henry E. Sigerist. xii + 256 pp. Illustrated. $3.00. 1941. The Johns Hopkins University Press.

Nymphs, Sylphs, Pygmies and Salamanders, and on the other Spirits." This essay is largely interesting as illustrating the survival of pagan mythology within the framework of Christianity. Not only were there angels, but there were pygmies, giants and nymphs, and why not? —God is almighty, and able to create such things. They crave human companionship, and must be treated kindly; if a nymph marries a man, she receives a soul through the sacrament of marriage. Let him scoff who never knocked on wood as a tribute to the forest people!

The volume is a valuable contribution to the historical literature. It presents in convenient and readable form the views on medicine, folk-lore and Christian living of one of the most colorful and forceful personalities of the Renaissance.

WINFRED OVERHOLSER

DO PHYSICAL THEORIES SUPPORT PHILOSOPHICAL DOCTRINES?[1]

IT is said that when the famous German mathematician, David Hilbert, was asked to address the joint session of the Congress on Mathematics and Engineering for the purpose of smothering somewhat the existing feeling of mutual disrespect between pure mathematicians on one side and technically minded engineers on the other, he began his address with the following words:

"There exists an opinion that mathematics and technics are hostile towards one another. This opinion is, however, not correct. Mathematics and technics are not hostile towards one another; mathematics and technics have never been hostile towards one another; mathematics and technics will never be hostile towards one another; mathematics and technics can not be hostile towards one another, because mathematics and technics have absolutely nothing in common."

Whether or not these not very tactful words of Hilbert describe correctly the relation between pure mathematics and its technical applications, they certainly can be applied very successfully to the relationship between theoretical physics and various philosophical systems.

Through the entire history of exact science, its findings were being used by philosophers (often with a century or so of delay) for the support of their own views and for discrediting the views of their philosophical opponents. One often hears about materialistic physics of the time of Isaac Newton, and the idealistic tendencies of relativity and the quantum theory. To take a most striking example, the recognition of "world-eater" was made compulsory, and the Heisenberg's "uncertainty relations" were strictly prohibited in the Soviet Russia, since they have been considered as contradictory to state—philosophy of dialectic materialism. On the other hand, idealistic philosophers would object to many other concepts of modern physics which would seem to them too materialistic. The aim of Professor Frank's book is to show that physical theories of to-day have absolutely nothing to do with different rivaling philosophical points of view, and "can be used for such arguments only if one interprets them according to the pattern of some cherished philosophy, disregarding the scientific meaning of modern physics." The author shows that "with the right interpretation, the results of twentieth century science can be used just as much and just as little as a characteristic of the change from materialism to idealism as the result of the physics of Newton or of any other period."

Being thus excommunicated from philosophy, the principles of physical science should be developed into a strict and unique logical system, in the construction of which "one must be careful to distinguish an experimentally testable assertion about observable facts from the proposal to represent the facts in a certain way by word or diagram."

[1] *Between Physics and Philosophy.* Phillip Frank. 238 pp. $2.75. 1941. Harvard University Press.

This line of thought, which, in a certain sense (but a "good one" this time), can be also called a "philosophy" was started by the Austrian physicist, Ernest Mach, and a good part of the book is devoted to the analysis of Mach's ideas and their further developments.

In other chapters the author analyzes such fundamental questions as the notion of "length" in Einstein's theory of relativity, Bohr's notion of "complementarity" in modern quantum theory, and its relation to the problem of *determinism* or *indeterminism*.

On the whole, the book will be very interesting reading for those who are not satisfied with the knowledge of factual findings of modern science, but want to know more about the fundamental principles and the construction of a logically self-consistent system of physical theory.

G. GAMOW

SCIENCE FOR HIGH SCHOOL STUDENTS[1]

THIS is an excellent modern text-book in general science for the ninth-year pupil or for the first year of high school. Every subject is presented as a question to be thought through and tested experimentally. The cumulative effect of establishing the scientific attitude and the scientific method is impressively successful.

The argument of such a text must rest upon the experiments and, in the first instance, on adequate drawings to represent the tests and the results. Hence the book is profusely illustrated and the clarity of both drawings and photographs has not been equalled. They are both convincing and fascinating.

In every respect the book is "teachable." There are ten units: air, water, food, sun energy, health, universe, weather, natural resources, communication and transportation, and reproduction. Each is divided into several chapters, 26 in all, and each chapter into four problems. Each chapter also carries review questions, applications to daily life and suggested activities for science clubs and leisure time. Each unit concludes with a summary, a test and suggested readings. All three authors are able teachers and have focussed here the painstaking experience of many years of teaching these young students.

This is definitely a book for study. It is not readable in the sense that a book for the layman is supposed to be. For that reason the title is perhaps too attractive and a bit misleading. It is not an adventure story nor an account of recent progress, as the title might imply. But it is a sound, expert and attractive text-book for children and a fine teacher for adults who seek an explanation of common phenomena and who want to learn to think scientifically.

GERALD WENDT

FIRST AID FOR THE GARDEN[1]

THE pest control measures called for each month—March to November—for gardens in the latitude of New York City are first tabulated, then concisely discussed. The pests and disease agents of ornamental herbs, shrubs and trees are made realistic by many line drawings and a few fine half tones. The new edition follows the arrangement for the first, with new material added in a chapter "After Four Years" and in one chapter each for garden troubles in the Middle West, the Southeast, the Southwest and California.

Dr. Westcott, technically trained and a practicing "plant doctor," is both sound and practical. No other book in English covers the pests and diseases of ornamental plants under one cover. The treatment is far less technical than German works in this field, and will not prove discouraging to authentic amateurs.

PHILIP BRIERLEY

[1] *Science on the March.* John A. Clark, Frederick L. Fitzpatrick and Edith Lillian Smith. Illustrated. xxvii + 572 pp. $1.72. 1941. Houghton Mifflin Company.

[1] *The Plant Doctor.* Cynthia Westcott. Revised Edition. Illustrated. xx + 297 pp. $2.00. 1941. Frederick A. Stokes Company.

THE PROGRESS OF SCIENCE

DEDICATION OF THE NATIONAL OBSERVATORY IN MEXICO

THE Inter-American Congress of Astrophysics, sponsored by the Government of Mexico in connection with the dedication of the new National Observatory at Tonanzintla, was characterized by two principal features, the quality of the many scientific contributions and the outstanding hospitality of our hosts. To most of the American scientists the congress provided a first visit to Mexico. The deep interest in science of the Mexican Government as evidenced by the President, General Manuel Avila Camacho, by the Governor of the State of Puebla, Dr. Gonzalo Bautista, and by many other Mexican officials, was a source of profound satisfaction to the twenty-seven scientists from the United States.

The dedication of the first Astrophysical Observatory of Mexico, on the morning of February 17, provided a spectacle that stands unrivalled in the mind of the writer. Ten thousand people of Mexico, mostly Indians, assembled before the new buildings of the observatory. With several bands, with innumerable flags and with holiday regalia, they had come, some from great distances, to dedicate an institution for pure scientific research. The picture of their upturned faces before the magnificent snow-capped peaks of Popocatepetl and Ixtaccihuatl is a symbol of Mexico, the new Mexico, that has chosen science to replace superstition.

From Mexico City, the town of Tonanzintla lies some 80 miles south of east, directly beyond the two great volcanic peaks. The region is a high rolling plateau, some seven thousand feet above sea level. The clear skies and uniform pleasant climate provide an excellent situation for astronomical observations. The new 27–31-inch Schmidt telescope, one of the three largest lens-mirror combinations in the world, commands not only the northern hemisphere of the sky, but also nearly all the southern hemisphere. Thus the Mexican astronomers have an opportunity to probe, with a new type of telescope, unstudied depths

INAUGURAL CEREMONIES BEFORE ONE OF THE NEW BUILDINGS

GENERAL MANUEL AVILA CAMACHO, THE PRESIDENT OF MEXICO
WITH THE PRESIDENTIAL PARTY EN ROUTE FROM THE LIBRARY BUILDING TO THE NEW TELESCOPE.

DISTINGUISHED SCIENTISTS AT THE DEDICATION
AROUND THE TABLE FROM LEFT TO RIGHT: PROFESSOR MANUEL S. VALLARTA, OF MASSACHUSETTS INSTITUTE OF TECHNOLOGY; DR. HARLOW S. SHAPLEY, OF THE HARVARD COLLEGE OBSERVATORY; GENERAL RODIQUEZ, FORUM PRESIDENT; PRESIDENT MANUEL AVILA CAMACHO; DR. RICARDO MONGES LOPEZ; DR. GONZALO BAUTISTA AND VEJAR VASQUEZ, SECRETARY OF EDUCATION.

of the Milky Way. The organizer and director of the National Observatory, Señor Luis Enrique Erro, plans to engage in systematic studies of the structure of our local universe of stars.

The American scientists arrived as a group at Mexico City on Sunday morning, February 15. Some used the day to orient themselves in this rapidly growing cosmopolitan city, while others simply relaxed after the strain of travel in an unaccustomed altitude. On Monday, following a brief visit to the pyramids of Teotihuacan, we were taken by automobile over the winding mountain roads through the forest slopes of Mount Ixtaccihuatl to the city of Puebla. There we were formally welcomed in the evening by Governor Bautista. From Puebla, on Tuesday, we attended the dedication ceremonies at Tonanzintla, some ten miles distant.

DR. ENRIQUE ERRO, DIRECTOR OF THE OBSERVATORY, LEADS A TOUR
DR. ERRO, RIGHT HAND EXTENDED; PRESIDENT CAMACHO, LOOKING UP; DR. BAUTISTA, GOVERNOR OF PUEBLA, STANDING BEHIND DR. ERRO; DR. CARLOS GRAEF, ASSISTANT DIRECTOR OF THE TONANZINTLA OBSERVATORY, IN THE LEFT FOREGROUND; DR. GEORGE Z. DIMITROFF, OF HARVARD UNIVERSITY, TO THE LEFT OF DR. GRAEF; PROFESSOR VALLARTA BEHIND DR. DIMITROFF.

The week at Puebla was almost entirely occupied with scientific meetings and official ceremonies. Some of the wives and a few of the scientists with tourist instincts took advantage of an occasional opportunity to slip out and bargain with the tradespeople for a cactus tablecloth or an onyx ashtray. But the business at hand was science, and it demanded one's complete attention.

The astronomical papers of the congress dealt primarily with problems of Milky Way structure, and more broadly with related problems of stars, stellar evolution and the material between the stars. No adequate review of the many contributions is possible in this limited space, but a few examples may be cited. Dr. Walter S. Adams, director of the Mount Wilson Observatory, opened the congress with a complete discussion of the atoms and molecules now known to

OBSERVATORY BUILDING TOWER

exist in interstellar space. The most recently discovered atom is that of iron. Dr. Adams demonstrated that the atoms and molecules are irregularly distributed in space, actual moving clouds being detectable. Dr. Joel Stebbins, president of the American Astronomical Society, from his photoelectric studies of the reddening of distant stars, showed that the irregular dust clouds of interstellar space possess a surprising uniformity—the distribution of particle sizes and possibly constitution appear to be constant, independent of the opacity of the cloud or its direction in space.

The perplexing problem of the evolution of stars was attacked by Professor Henry Norris Russell, of Princeton, and touched upon by Dr. Otto Struve, director of the Yerkes and McDonald Observatories. On the basis of the modern theory that stellar energy is derived by atomic transmutations, Professor Russell showed that a time scale much greater than three billion years would require an unobserved excess of stars that equal the sun in mass, but that are much brighter and hotter than the sun. He pointed out, however, that the white dwarf stars appear to be too old, and the supergiant stars too young, for such a short time scale of evolution. Dr. Struve discussed the rotations of stars, presenting new observations that challenge all theories of stellar evolution. The hot massive stars of the Pleiades are all rotating at high speeds, dangerously near the stability limit, while the stars near the center of the cluster turn even faster than those near the edges.

Results as to the detailed structure of the Milky Way were presented by Dr. Harlow Shapley of Harvard and his collaborators. Dr. Shapley's studies of the distant variable stars have pushed the outer edge of the Galaxy to a distance equal to our distance to the center, about thirty-thousand light years.

Filled with such new astronomical knowledge we returned to Mexico City for a Sunday of needed rest and relaxation. Monday saw our automobile cavalcade, escorted by motorcycle policemen, over the mountainous roads some two hundred miles west to Morelia. Just before dawn on Tuesday, we were awakened by band music and firecrackers. It was Flag Day. From this early awakening, we proceeded to the picturesque village of Tiripetio, in which are located the reconstructed buildings of the Col-

STRUCTURE HOUSING THE TELESCOPE WHICH IS LOCATED AT PUEBLA, MEXICO.

legio San Nicolas, founded in 1540. In this, the oldest university of the American continents, honorary degrees were awarded to Drs. Adams, Russell, Shapley and Vallarta.

Tiripetio proved to be our one opportunity to observe a natural Mexican village, unspoiled by modernism. The members of the band wore serapis and overalls, while the oxen were decorated with flowers for the great occasion. Education, however, is an important factor in this small village. The school children were all on their best behavior because the school was being inspected by government officials.

During the remaining two days spent at Mexico City, the members of the congress were honored with a luncheon given by President Manuel Avila Camacho in the National Palace, and with a luncheon given by the American Embassy through the courtesy of Ambassador and Mrs. George S. Messersmith. A geophysical conference at the University of Mexico provided mental food during these last days, and finally the members of the congress dispersed regretfully on Thursday, February 27.

MARIMBA PLAYERS AT MIL CUMBRES

THE NEW 27–31-INCH TELESCOPE
THIS SCHMIDT PHOTOGRAPHIC TELESCOPE AT THE NATIONAL OBSERVATORY AT TONANZINTLA WAS BUILT AT THE HARVARD OBSERVATORY UNDER THE DIRECTION OF DR. DIMITROFF.

Of many disconnected memories, the writer recalls vividly the remarkable English-Spanish and Spanish-English translations of scientific papers by Dr. Carlos Graef and Alfredo Banos, the diplomatic smoothing of our travel path by Senor Salvador Duhart, first secretary of the Mexican Embassy, the feel of crisp cool dry air under the bright Mexican sun and the music of the marimba at Mil Cumbres on the trip to Morelia.

From the many pleasant contacts with the Mexican people of all classes, from the scientific understanding of our Mexican colleagues and from the great interest of the Government of Mexico in our welfare and activities, we carried away the fine impression that there is a true and binding tie of friendship between the United States of Mexico and the United States of America.

FRED L. WHIPPLE

ELSIE CLEWS PARSONS, LATE PRESIDENT OF THE AMERICAN ANTHROPOLOGICAL ASSOCIATION

ELSIE CLEWS PARSONS died on December 19 shortly after a field trip to South America and just before the meeting of the association over which she was to preside. It is difficult to do adequate justice to her work and her personality. Born under circumstances that would have shaped her life in a conventional pattern, her eagerness for knowledge and her keen interest in human affairs made it possible for her to follow serious studies without breaking with the exactions of social life. After graduation from Barnard College in 1896 she continued her studies under Giddings, and began to teach and to write. Her early work is characterized by a strenuous revolt against convention, by a clear recognition of the historical origins of our institutions which, in our modern, complex society, have lost much of their meaning. It exhibits a courageous expression of a purely intellectual criticism of fundamental forms of our modern ways of life. As time went on this critical attitude led her to the unavoidable desire to learn how other societies have solved the problems that beset us. Thus she turned from a sociological study that lays primary stress upon the complexities of our culture to the wider inquiry, the question of the manner in which more primitive or alien societies have solved their problems—a necessary preliminary of the study of what is generally human and of what is historically determined. The position of women in society, the forms of the family, demanded inquiry from a wider point of view. In the United States we are in the fortunate position for those who study problems of this type that much remains in the culture of our native Indian population and in that of the poor Negroes that lends itself to factual investigation. Dr. Parsons embraced this opportunity avidly and spent unlimited time and energy in the study of these remains. She was attracted by the ceremonial life of the sedentary Indian tribes of Arizona and New Mexico and became the most outstanding authority on this subject. It is fortunate that it was given to her to complete her comprehensive work on the religion of the Pueblo Indians in which she combined her own rich studies with the available printed and manuscript resources. In her researches she welcomed the help that other competent observers were able to give, and much of the research work that has been done during the last few decades is due to her stimulation of young scientists, to whose attention she called problems and whom she enabled to carry through field work that otherwise would have remained undone. It was her good fortune that she was able to render such material assistance. It was her merit that her devotion to science prompted her to use her position unselfishly for the promotion of scientific work that she considered important.

In the pursuit of her southwestern studies the influence of Spanish culture upon native life became a problem of paramount importance. It attracted her not only as a local problem, but rather as a study that throws light upon the processes involved in the history of culture, for we find here cultures not yet overwhelmed by modern civilization but who have worked out a compromise between the old and the new. The richest fruit of her studies on this subject is her book "Mitla, Town of the Souls, and other Zapoteco-speaking Pueblos of Oaxaca in Mexico." During the last few years she extended these inquiries, which had a great fascination for her, over South America also. It is undoubtedly due to this interest in historic amalgamation rather than in the extermination of foreign cultures that she gave consider-

ELSIE CLEWS PARSONS

able time to the collection of data on Negro folk life, both in North America and in the West Indies. Although cultural survivals are scanty in most parts of North America, the more southern regions, the West Indies and South America, present interesting problems of intermingling of cultures.

In contrast to her early sociological work her later work shows a most conscientious desire for factual accuracy. For this reason many of her books are source material which furnish the basis for her short theoretical papers.

The experiences gained by personal, intimate contact with the forms of foreign cultures and with individuals living in these cultures was for her not only a method of scientific inquiry but also a guide to life. Understanding the emotional appeal of historically conditioned behavior, she recognized the difficulties of a purely intellectual attack upon catch phrases and meaningless symbols, but demanded of herself and leaders of public opinion the highest degree of intellectual honesty that requires the willingness to subject the emotional attachment to custom to rigid intellectual inquiry and to accept the results of the latter as guides of action.

Her unselfish devotion to science has few equals. Always ready to help young scientists in the wide domain of anthropological research and particularly of her own chosen field, she has done much to advance anthropological work in our country. The only return she demanded for her help was industry and serious work. Without her help many of the important contributions of late years would not have seen the light. Her interest in folk-lore as a source of the understanding of culture and cultural

processes led her to the most liberal support of the American Folk-Lore Society, whose broad field of publication and research was made possible almost entirely by her generous support.

In her own life she was uncompromising where her convictions were concerned, ready to recognize the good even in forms not congenial to her independent mind, and unselfish in all her thoughts and actions.

We lament her loss, but the memory of her devotion to her ideals will live on among us and lead us to emulate her example, intolerant towards ourselves, tolerant towards others, disdainful of all selfish pettiness and truthful in thought and action.

FRANZ BOAS

THE "QUEEN" OF MESCALITAN ISLAND

FIFTY years ago Mescalitan Island was surrounded by the waters of the Goleta Estero. To-day, the estero has filled with muck from the erosion of the nearby mountains, and the Santa Barbara (California) airport occupies the place where, five hundred years ago, a great Indian village stood.

Prior to the construction of the airport, an expedition of the Santa Barbara Museum of Natural History made excavations which have yielded some of the most interesting and valuable data yet uncovered upon the phases of the *Canalino* culture of the Chumash Indians. Certainly it has yielded one of the most interesting single specimens of American Indian yet brought to light.

A total of seven burial grounds were found. In each a different custom prevailed as to the method of interment and accompanying artifacts. Each of these burial plots represents a phase of the *Canalino* culture which to date had not been recognized. In one of these earlier cemeteries, the skeleton of a young woman(?) was uncovered—the skeleton having been buried upon the highly decorated shoulder blade of a whale, which acted as a bier.

EXCAVATORS AND SKELETON
WITH STONE BOWL IN LATE CANALINO CEMETERY.

SKELETONS OF THREE INDIVIDUALS
BONES OF AN ADULT AND CHILDREN.

Background by Stanley Edwards

THE MESCALITAN ISLAND GRAVE IN THE SANTA BARBARA MUSEUM

The *Canalinos*, or "Channel People," buried their dead face down, arms and legs drawn up in the flexed position. Usually a few shell beads accompany the skeleton—sometimes a bowl of sandstone or steatite, together with bone or stone implements.

On very rare occasions the later phases covered the grave with slabs of whale bone, which served to mark the grave and to protect it from marauding animals. This is the only case in which the whale bone has acted as a bier upon which the body lies.

The whale scapula is decorated with *Olivella* disc beads around the rim, inlaid by the use of asphalt. The spine was removed by careful carving and two large abalone shells countersunk into the bone on either side of the skeleton. These abalones are surrounded by a border of the small *Olivella* disc beads. Here and there, throughout the distal end of the scapula, the calluses of the Giant Keyhole Limpet are inlaid. These calluses are the hardened rims of the orifice of the shell and make elongated rings.

The skeleton also had a string of steatite beads of unique design strung across the shoulders. These are long tubular beads of black steatite with *Olivella* inlay about the center. Beside the skull a small sandstone bowl, inlaid around

the rim, was found, while down the spine a string of *Olivella* beads was stretched and short strands were found about each knee.

The entire skeleton was excavated in one block and moved to the Santa Barbara Museum of Natural History, where it has been installed as a "habitat group"—if a dead Indian can be said to have a "habitation"—complete with the excavation and tools used in the work. A painted background showing the surrounding country gives a convincing picture of the region occupied by the early Indians of Santa Barbara.

PHIL C. ORR

CAMOUFLAGE EXHIBIT AT THE FRANKLIN INSTITUTE

Is camouflage really important to national defense? Can we save strategic military locations from air attacks by making airports look like cornfields and factory roofs resemble swimming pools? To show some of the ways camouflage can be made effective, the Franklin Institute recently opened an extensive exhibition in cooperation with the War Department and the Philadelphia Council of Civilian Defense.

The historical background of camouflaging is a long and interesting one. The Bible tells how Rahab concealed spies under stalks of flax on her roof, and the wooden horse at Troy was the deciding factor in the victory for the Greeks. In the records of the Civil War, it was written on April 18, 1862, that while sailing up the Mississippi, past enemy forts, Admiral Porter ordered all the masts of the ship to be covered with branches to make it appear less conspicuous. In World War I, black stripes were painted on the sides of battleships and destroyers to deceive the eyes of the attackers in judging their direction. Dazzle painting was used to make it difficult for enemy

A RESERVOIR, TOP CENTER, AS IT APPEARS WHEN UNCAMOUFLAGED

TERRAIN CAMOUFLAGE IS SHOWN BY THE RAILROAD TRACKS TUNNELED WITH GARNISHED NETTING AND THE FALSE RAILROAD BRIDGE "ONE MILE" TO THE RIGHT OF THE ACTUAL BRIDGE.

THE SAME RESERVOIR AFTER CAMOUFLAGING

THE GARNISHED NETS WHICH ARE USED TO CONCEAL THE RAILROAD BRIDGE WOULD BE DROPPED DURING A RAID TO ELIMINATE THE SHADOWS ON THE LEFT SIDE AND REFLECTIONS ON THE RIGHT.

submarines to sight the most vulnerable parts.

Military authorities agree that the more industrialized a country is, the more vulnerable it is to attack. So now we must plan effective concealment not only from the ground and sea, but from the air as well.

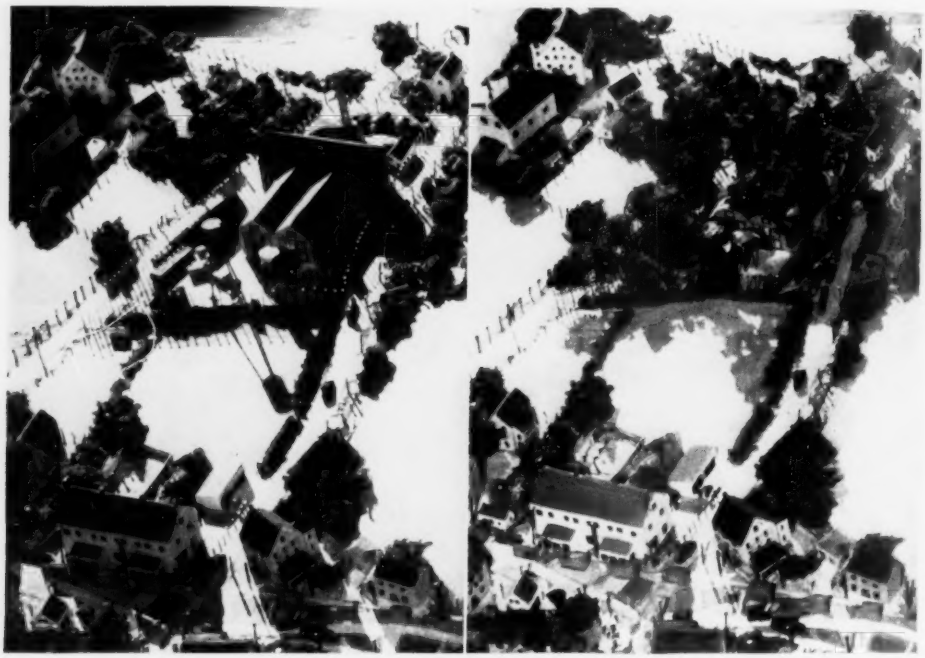
For years, Germany has been perfecting its methods of camouflage. In one branch of their protective endeavor, British women are constantly making patterns on nets to cover their tanks in the field. If camouflage is to be successful in this country, means must be found to conceal radio towers, oil storage tanks, giant power houses and many other important industries.

This exhibition explains how some of these problems can be understood and solved. By using scale models of the areas of production, the appearance is shown before and after camouflage.

One model shows how modern, arrow-straight, slashed-through super-highways, perfect though they are in peacetime, are easy bomb-targets for speeding enemy planes. By way of contrast, long curved highways which follow the contours of the landscape are more suitable for trucks and tanks to seek refuge in the foliage on the side of the road if an air raid should occur. The turns and twists make it almost impossible for flights of planes to follow the road with either bombs and bullets.

Another model deals with the problem of "hiding" a railroad bridge by placing a false one about a mile away. During a raid, painted nets are lowered on both sides of the real bridge—on the north to kill the shadow and on the south to eliminate bridge reflection.

Even an amateur could spot a factory from the air, just by the roof and the rows of parked cars near it, which are ample identification. In camouflage, effort is always made to have these build-



CAMOUFLAGING A LARGE INDUSTRIAL BUILDING IN A RURAL DISTRICT
Left: IN THE UPPER PART OF THE PICTURE IS THE BUILDING BEFORE CAMOUFLAGING. *Right:* FALSE TREES AND DUMMY STRUCTURES MAKE THE BUILDING BLEND WITH THE LANDSCAPE.

ings fit into the natural landscape. In rural districts, false trees and dummy buildings help make this possible. In one model, the roof is covered with luminous paint, and weeds and rough grass are put around the edge to make it look like a stagnant pool.

Saw-toothed roofs can be constructed to look like swimming pools in southern climates, or skating rinks with toboggan slides in the snowy regions. In either case a parking lot can be turned into a baseball diamond and the cars parked under nearby shrubbery. The factory windows are varnished and powdered to remove the shine.

It has proved effective to camouflage even the soldiers. White is worn by snow troops, and printed cotton suits are used in other sections to fit into nature's background.

All these models may be seen from a balcony at the Franklin Institute. Some are built to scale so that when looking down at them the visitor has the same view a pilot has at 20,000 feet. This helps to give an idea of the tremendous precision that is necessary to hit the target, and how easily well-planned camouflage effects can completely confuse the enemy.

One section of the exhibit is devoted to an explanation of the principles of concealment set forth by Abbott Thayer, an American artist, whose book published in 1909 is still the most important reference book on this subject. Of these principles, the four basic ones are: (1) the resemblance between the object and the background, (2) obliterative shading, (3) the methods of blurring the outline by using a disruptive pattern and (4) eliminating shadows by structural adaptations. The markings on a jaguar, zebra and giraffe, which make them well suited to their environment, are examples of the first principle. The outlines of their bodies are completely lost in the

dense foliage when they are more than eight or ten feet away.

Another angle of this immense camouflage problem is the importance of perception. Black and white drawings show how line and contour fool us even more than color.

It is too late to reconstruct our modern industrial centers and to tear up our super-highways, but every effort must be made to distort these production landmarks which serve as a guide to enemy aircraft.

EMILY DUANE WALLACE

MATHEMATICS RETURNING—AT LEAST FOR A TIME

ONCE mathematics occupied an important place in every high-school and college curriculum. Now it has largely disappeared, having been displaced by the great number of other sciences and by non-scientific subjects which are now demanding attention. It has been going the way the classical languages have gone, and hardly more slowly. First, college degrees were given upon the completion of courses having no required work in mathematics at all. Then the secondary schools began waiving their mathematics requirements for graduation. Emphasis was placed upon subjects having "practical value" for solving the problems young boys and girls, young men and women, would have to meet upon their graduation from schools and colleges.

This change in curriculum was not made on the basis of experiments to determine the relative values of various disciplines in education. It was not made on the basis of elaborate and coherent theories about the relative usefulness in education of various subjects, such as those which Herbert Spencer developed three generations ago. Mathematics was simply crowded out. The subjects available for college credits increased ten-fold while the length of the college course remained fixed and the prerequisites for entering college were not doubled. At the University of Chicago, as long as twenty-five years ago, there were more than 600 majors of work available for undergraduate credits, while only thirty-six were required for graduation. They were subject, however, to the requirement that they should include one or more sequences in one field or in closely related fields.

Naturally as the new subjects and courses made headway, the old were partially or entirely displaced for the many who in earlier days had struggled with the perplexities of algebra, geometry and trigonometry, but not of course for a relatively few specialists who increased greatly in absolute number and went immeasurably beyond their predecessors. Ignorance of mathematical subjects was not a reason for apology, but more often one for boasting. Not only were the technicalities of algebra and geometry beyond the horizons of students graduating from high schools and colleges, but so also were the elements of arithmetic and arithmetical processes.

Recognition of the conditions that had developed is now forced by the demands for young men in the Engineer Corps of the Army and the Navy, in the Air Corps, in the Signal Corps and in the Artillery. It is being found that a large fraction of those who are examined for these services are wholly unfamiliar with elementary geometric relations and even can not perform correctly simple arithmetical computations. This mechanized war demands skills in these fields, not on the part of a few leaders, but on the part of hundreds of thousands.

Consider the Air Corps of the Army and Navy. Every pilot and navigator and bombardier must be proficient in arithmetic and geometry. In fact, these

are the elementary prerequisites for an understanding of the serious technical problems that must be mastered before a cadet is qualified to become a member of the combat crew of a plane. In the early days of the war it was often stated with good reason that it takes two years to make an airplane pilot or navigator or bombardier. But two years are not available. Tens of thousands of planes are scheduled for production in the next few months and more than one hundred thousand next year. Since the minimum average crew of combat planes includes three men, hundreds of thousands of young men must now study mathematics —elementary mathematics, it is true, but mathematics much beyond what has been taught on any considerable scale in the recent past. They must also master related subjects in physics and astronomy. The situation would be serious even if there were not large demands for similarly trained men in several other branches of the armed services and in industrial laboratories.

The ways are very numerous in which the war is changing our modes of living, our habits of thought and even our ideals. The place of mathematics in education is simply one of them that happens to be of great importance at present. Mathematics must be studied now by hundreds of thousands, but whether it should regain and retain its former place in school curricula after the close of the war is a question that can be answered, if at all, only after thorough investigation and, if possible, experimentation. The same can probably be justly said of all the other subjects in our educational curricula and of the collateral school activities that take up a considerable fraction of students' time. Perhaps these extra-curricular activities are the most important part of education. Perhaps scholars have become too critical of everything except current ideas and look too often with cynicism on ideals our predecessors revered. Perhaps there is a lesson in the fact that when old graduates get together they almost invariably follow their praises of the professor who benefited them most with the statement that they learned very little about the subject he taught. F. R. MOULTON